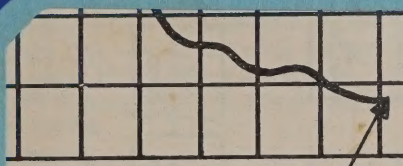
EICO VOM 221

INSTRUCTION MANUAL FOR



Model 221

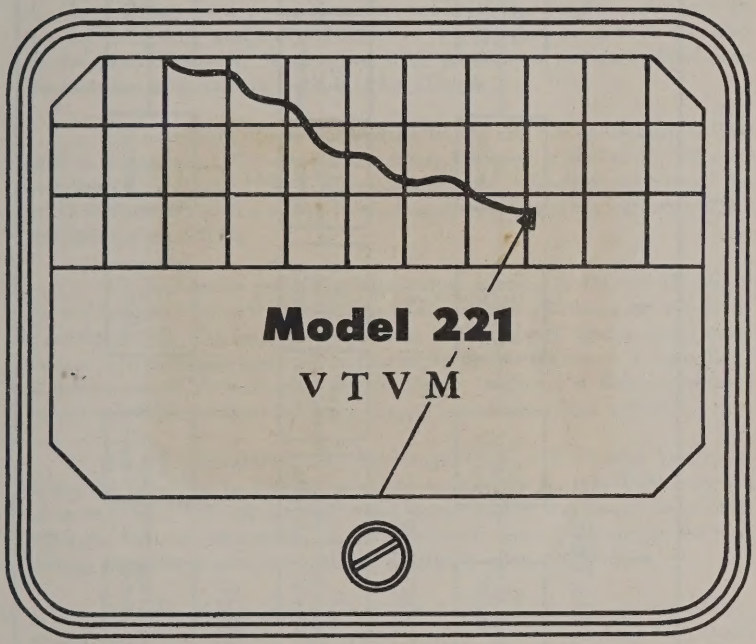
VTVM

EICO

ELECTRONIC INSTRUMENT CO., Inc.

84 WITHERS STREET, BROOKLYN 11, N. Y.

INSTRUCTION MANUAL FOR



EICO

ELECTRONIC INSTRUMENT CO., Inc.

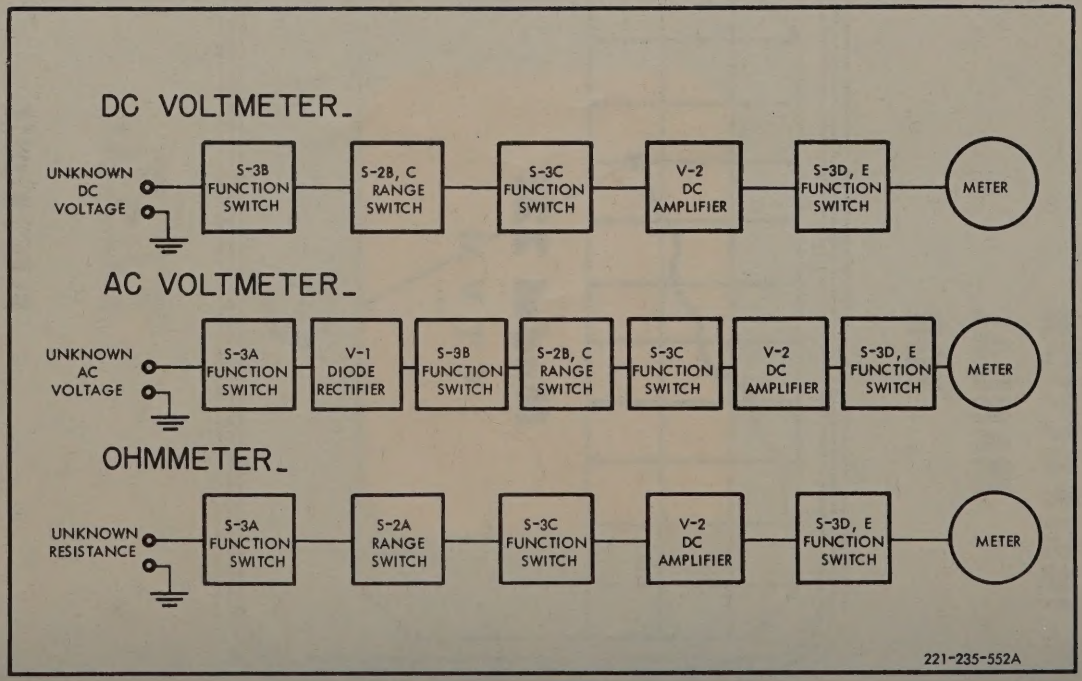


Fig. 1 - Block Diagram

GENERAL DESCRIPTION

The EICO Model 221 Electronic Volt-Ohm Meter is a high quality VTVM that is especially suited for use in television, f-m, and a-m radio servicing. Featuring a rugged and easy reading 4 1/2" meter, this instrument provides entirely electronic measurement of a-c voltage, d-c voltage, decibels and resistance.

Complete overload protection is provided electronically on all a-c voltage, d-c voltage, and ohmmeter ranges. To eliminate the need for reversing the test leads on d-c voltage measurement (when a negative d-c voltage is to be measured), positive and negative d-c positions have been provided on the function switch. A zero centering position on the meter facilitates discriminator alignment in f-m and a-f-c circuits.

This instrument allows measurement of d-c and a-c voltages up to 1000 volts in five ranges. The d-c voltage range can be extended to 30,000 volts with the EICO Model HVP-1 High Voltage Probe. Another accessory, the EICO Model P-75 RF Probe extends the frequency range of the instrument (20 - 200,000 cps) to 200 Mc.

The readings on the d-c voltage ranges are accurate within 3% and on the a-c ranges within 5% of full-scale (the multiplier resistors used are accurate within 1%). As the input impedance is 25 megohms on d-c and 3 megohms on a-c voltage ranges, the current drawn by the instrument is negligible, so there is no problem of error due to circuit loading. A balanced bridge circuit maintains constant accuracy despite variations in line voltage.

On the ohmmeter ranges, advantage is taken of the high sensitivity of the d-c amplifier to provide resistance measurements up to 1000 megohms using only the 1 1/2 volt battery. This feature avoids any danger to delicate apparatus that may be tested with the instrument, since it eliminates the high voltage normally encountered in high resistance measuring circuits.

The user of the instrument will benefit from direct reading scales, simple operation, and the dependable quality that results from high grade components, and careful engineering and testing in the field. It will prove to be an extremely valuable tool for signal tracing, alignment, for voltage and resistance measurements in television and radio receivers, and for testing many types of electrical equipment.

SPECIFICATIONS

D-C Voltage Ranges:
0 to 5, 10, 100, 500, 1000 volts
(to 30 KV with HVP-1 probe)
Input impedance: 25 Meg.

A-C Voltage Ranges:
0 to 5, 10, 100, 500, 1000 volts
(Special scale for 0 to 5 volts)
Input impedance: 3 Meg.

Electronic Ohmmeter Ranges:
0 to 1000 ohms, 10,000 ohms,
1 Meg., 10 Meg., 1000 Meg.
(Measures from 0.2 ohm to 1000 Meg.)

Decibel Ranges: -20 to + 55 db

Frequency Range: 20 - 200,000 cps
(Up to 200 Mc with P-75 probe)

Accuracy: d-c volts, ohms -- ± 3%
a-c volts -- ± 5%

Power Supply: 115 v, 50-60 cps, 10 w

Ohmmeter Battery: 1 1/2 v dry cell

Tubes: 6X5, 6H6, 6SN7

Overall Dimensions: width - 6 in.,
height - 9 7/16 in., depth - 5 in.

Weight: 10 pounds

Cabinet: Blue grey wrinkle
lacquer on steel

Panel: 3 color, deep etched

OPERATING INSTRUCTIONS

INITIAL STEPS: Check the mechanical zero adjustment of the meter pointer when the power is off. If the pointer is off zero, turn the slotted screw directly beneath the meter face until the pointer is brought to zero.

Plug the line cord into the 60 cycle, 115 volt a-c supply, turn the power on with the "ON-OFF" switch, and allow a normal warm-up time (about one minute).

Insert the phone plug, P1 (on the DC test lead), in the DC jack, J1, on the panel. Insert the pin plug, P2 (on the AC-OHMS test lead), in the AC-OHMS jack, J2, on the panel. Insert the banana plug, P3 (on the COMMON test lead), into the COMMON (ground) jack, J3, on the panel. This is the COMMON lead for all functions.

CAUTION: Never connect the COMMON lead to a high voltage point as this will place the meter chassis and case at a high voltage above ground.

When working with high voltages, avoid contact with or close proximity to high voltage points. If possible, attach the test leads with the power off in the circuit to be measured. After the leads are attached, turn the power on and take the reading.

D-C VOLTAGE MEASUREMENT: Set the FUNCTION switch to "+DC" or "-DC VOLTS", the RANGE switch to desired voltage range, and then use the ZERO ADJ. potentiometer to bring the meter pointer to zero*. Clip the COMMON lead to ground or the low side and touch the DC probe to the high side of the

source to be measured. On the 5V and 500V ranges, read the 0-5 AC-DC scale (black); on the 10V, 100V, and 1000V ranges, read the 0-10 AC-DC scale.

A-C VOLTAGE MEASUREMENT: Set the FUNCTION switch to "AC VOLTS", the RANGE switch to the desired voltage range, and then use the ZERO ADJ. potentiometer to bring the meter pointer to zero*. Clip the COMMON lead to ground or the low side and touch the AC-OHMS probe to the high side of the source to be measured. On the 5V range, read the special 5VAC scale (red); on the 500V range, read the 0-5 AC-DC scale (black); on the 10V, 100V, and 1000V ranges, read the 0-10 AC-DC scale.

RESISTANCE MEASUREMENT: Set the FUNCTION switch to "OHMS" and the RANGE switch to the desired ohms range; connect the COMMON lead to the AC-OHMS lead and then use the ZERO ADJ. to bring the meter pointer to zero; separate the COMMON lead from the AC-OHMS lead and then use the OHMS ADJ. potentiometer to set the meter pointer so that it reads exactly full-scale. Clip the COMMON lead to one terminal of the unknown resistance and touch or connect the AC-OHMS probe to the other terminal. Read the OHMS scale on the meter. On the RX1 range, read the OHMS scale directly in ohms; on RX10, RX1000, and RX10,000 ranges, multiply the scale reading by 10, 1000, and 10,000 respectively and read in ohms; on the RX1MEG range, read the scale directly in megohms. Note: The small reading noted on the lowest range is the resistance of the leads.
CAUTION: Never leave the FUNCTION switch set at the "OHMS" position as this will greatly shorten the life of the ohmmeter battery.

DECIBEL MEASUREMENT: The instructions for decibel measurement are the same as for a-c voltage measurement except that the DB scale is read. To the reading on the DB scale, add the number of db shown on the meter as corresponding to the a-c voltage range used. Correction for measuring across different impedances is included in the APPLICATIONS section under "OUTPUT METER".

ZERO-CENTER INDICATION: See APPLICATIONS section.

APPLICATIONS

OUTPUT METER: When the RANGE switch is set at 10V and the FUNCTION switch is set at AC VOLTS, the power level in a 500 ohm circuit can be read directly in decibels on the DB scale, which is calibrated from - 20 to + 15 DB, based on a reference level of 6.0 milliwatts and 500 ohms. This reference level is marked "0" decibels, and corresponds to 1.73 vac on the 0-10 volt scale. To measure higher levels, proceed as instructed in the OPERATING INSTRUCTIONS section under "DECIBEL MEASUREMENT".

The DB scale on the meter is calibrated across a 500 ohm line. If the DB measurement is being made across an impedance other than 500 ohms, use

*See note on electrostatic pickup in the MAINTENANCE section, page 9.

the correction table below to obtain the number of DB (corresponding to the actual impedance) that has to be added to or subtracted from the measured value. This correction is separate from the correction made for the a-c volts range used.

ACTUAL IMPEDANCE	CORRECTION FACTOR	ACTUAL IMPEDANCE	CORRECTION FACTOR
4 ohms	+ 21 db	200 ohms	+ 4 db
8 ohms	+ 18 db	300 ohms	+ 2.2 db
16 ohms	+ 15 db	500 ohms	0 db
50 ohms	+ 10 db	600 ohms	- 0.8 db
75 ohms	+ 8.2 db	1000 ohms	- 3 db
150 ohms	+ 5.2 db	2000 ohms	- 6 db

RECEIVER ALIGNMENT: To use the DB scale for receiver alignment: 1) connect the AC-OHMS probe and the COMMON lead across the voice coil; 2) set the FUNCTION switch at AC VOLTS and the RANGE switch at 10V; 3) feed a 400 cycle modulated r-f or i-f signal into the receiver. Keep the receiver volume control at maximum, and adjust the signal generator output to produce a small deflection on the DB scale. As alignment adjustments are made, thus increasing the sensitivity, the DB scale will show the improvement directly in decibels. The effective attenuation of wave traps, in decibels, can be determined by noting the decrease in decibels as the trap is tuned through resonance.

ZERO-CENTER APPLICATIONS: In some applications, for example in aligning the discriminator in f-m or a-f-c circuits, it is convenient to use a zero-center d-c voltmeter, because the d-c output of the discriminator changes from + to - to + as the secondary of the discriminator transformer is tuned or as the input frequency is varied above and below resonance.

Zero-center indication can be obtained as follows: 1) set the FUNCTION switch at either "+DC" or "-DC VOLTS", 2) set the RANGE switch at "5V" (higher if necessary); 3) turn the ZERO ADJ. knob to bring the meter pointer to the special zero mark (-0+) beneath the center of the DB scale; 4) connect the COMMON lead to the low side of the discriminator load; 5) connect the DC probe to the high side of the discriminator load; 6) refer to the special center scale zero mark; when the secondary of a conventional discriminator is correctly tuned, the DC output is zero and the meter will indicate zero.

POWER OUTPUT IN WATTS: Use formula: $\text{Watts} = \frac{\text{Output Voltage Squared}}{\text{Load Impedance}}$

EXAMPLE: The maximum undistorted output voltage across a 2 ohm load is 5 volts.

$$\text{Power Output} = \frac{5X5}{2} = \frac{25}{2} = 12.5 \text{ Watts}$$

THE EXCLUSIVE EICO MAKE GOOD GUARANTEE

Each EICO kit and instrument is doubly guaranteed by Eico and your jobber to contain only selected quality components. EICO guarantees to replace any component which might become defective in normal use if returned to the factory, transportation charges prepaid, within 90 days of original purchase. EICO guarantees all kits assembled according to Eico's simplified instructions will operate as specified therein. EICO guarantees to service and calibrate every Eico kit and instrument at nominal charge.

This guarantee is valid only when the enclosed card is properly filled in and returned for registration.

ELECTRONIC INSTRUMENT CO., Inc., 84 Withers St., B'klyn 11

IMPORTANT NOTICE

In accordance with EICO'S modernization policy we endeavor to keep owners of EICO equipment advised as to latest engineering developments and changes. We ask that you please fill in the attached card and mail it to us immediately. This will register your instrument and allow us to extend to you the full scope of our services.

This instrument or kit was shipped from our factory in perfect condition, carefully inspected to prevent shortages and defects. However, should any shortage or defect occur, notify factory, specifying date and inspector's number as indicated on the guarantee.

If instrument or kit parts are received in damaged condition, notify the CARRIER at once. We are not responsible for any damage caused in transportation. Our responsibility (other than our standard guarantee) ceases to exist upon our delivery to the carrier.

PLACE
2c
STAMP
HERE

ELECTRONIC INSTRUMENT CO., Inc.

84 Withers Street

Brooklyn 11, N. Y.

EICO

EICO

REGISTRATION CARD

PLEASE REGISTER ME AS OWNER OF INSTRUMENT

MODEL #..... SERIAL #..... DATE PURCHASED.....

DISTRIBUTOR .....

NAME .....

STREET .....

CITY..... STATE..... 2 1955

OCCUPATION .....

REMARKS .....

NOTE: Guarantee is valid only if this card is filled in and returned for registration within ten days.

FORM 754

OSCILLATOR STRENGTH: The negative d-c voltage developed on the oscillator grid is always directly proportional to the strength of oscillation. This voltage can be measured very readily at the oscillator grid while the band switch is turned to the various bands, and in each of its positions the main tuning condenser is rotated from minimum capacity. This will give an indication of the strength of oscillation at all frequencies within the oscillator's range.

A-V-C VOLTAGE: The automatic volume control voltage developed by the incoming signal can be measured at a number of places in the receiver. This negative voltage first appears across the diode load resistor. It may also be measured along the a-v-c bus and at the grids of the r-f tubes being controlled. The d-c voltage measured at the diode load resistor is a very convenient output indication during receiver alignment.

Owing to the high input resistance of this instrument, it is possible to measure bias (a-v-c) voltage on the grid of r-f and i-f amplifier tubes without disrupting the signal.

D-C SUPPLY VOLTAGES: Power supply d-c voltages can be measured at the rectifier filaments and in the filter circuits. Plate, screen, and cathode d-c voltages can be measured at the corresponding pins of the tube sockets.

BIAS CELL VOLTAGE: This instrument will accurately measure the voltage of a bias cell. Current drawing voltmeters are not capable of making this measurement and in many cases will damage the cell.

TELEVISION RECEIVER ADJUSTMENTS: This instrument will measure the d-c voltage developed across the second-detector load resistor in the picture channel of a television receiver. This measurement is most useful when adjusting antenna orientation as well as when adjusting antenna matching sections.

GASSY TUBES: One effect of a gassy tube is to reduce the normal negative grid bias, or even make the grid positive. This instrument is ideal for measuring the voltage directly at the control grid of any tube in order to determine whether or not this effect is present. Excessive gas will cause the tube to cease operating normally, and in an audio amplifier will usually cause the volume control to become noisy. This amount of gas will not always produce a noticeable change in the operation of the radio receiver. Consequently if repeated difficulty is experienced with volume controls becoming noisy, in this type of circuit, this instrument should be used to check for incorrect bias.

A-C VOLTAGES: The a-c voltmeter within the instrument is extremely useful in measuring all a-c voltages encountered in the average radio receiver. The measurements that can be made include all voltages from power transformer secondaries, audio signal voltages at grids and plates of amplifiers, and audio voltages developed across the output transformer or voice coil (as an indication of output during receiver alignment).

ACCESSORIES

R-F PROBE P-75 (K): An EICO R-F probe (P-75K - kit form, P-75 - factory wired) for use in measuring voltages up to 50 volts and to 200 Mc is available to extend the uses of the instrument. This probe is simply plugged into the D-C jack of the instrument and the r-f voltages are read on the regular D-C scales.

HIGH VOLTAGE PROBE HVP-1: An EICO High Voltage Probe HVP-1 (factory wired only) for measuring d-c voltages up to 30KV is available to extend the uses of the instrument. The probe may be supplied with a multiplier resistor of 240 Megohms to give a high voltage range of 10,000 volts or with a multiplier resistor of 740 Megohms to give a high voltage range of 30,000 volts.

CIRCUIT DESCRIPTION

GENERAL: The meter measures either d-c or a-c voltages by making use of the rectifying and amplifying characteristics of vacuum tubes. The input impedances are very high (d-c - 25 megohms, a-c - 3 megohms), and the current used to actuate the indicating meter is not taken from the circuit being measured. A bridge circuit, used to stabilize the operating voltages of the tubes, provides constant accuracy despite line variations. When used as an ohmmeter, the instrument will measure resistances between zero and 1000 megohms. Decibel measurements between - 20 and + 55 db can be made using the DB scale.

D-C AMPLIFIER CIRCUIT: (See Figures 1 and 3) A balanced bridge circuit is used in the d-c amplifier, comprising the twin triode V-2, a common plate load resistor R-3, and the balanced cathode load resistors R-10, R-11, and R-12. The meter M-1 is connected across the two cathodes of V-2. In the normal condition, a reference current flows through V-2B, which has a grounded grid. Current flow through V-2A is adjusted by means of the ZERO ADJ. control R-12 to equal the current flow in V-2B. The meter then reads zero.

OPERATION AS A D-C VOLTMETER: (See Figures 1 and 3) The circuit for operation as a d-c voltmeter is as follows: The unknown voltage is applied across the connectors J-1 and J-3 (ground). The FUNCTION switch S-3 connects the range voltage divider across J-1 and ground. A voltage, depending on the RANGE switch setting, is then applied to the grid of d-c amplifier V-2A. This grid voltage unbalances the bridge circuit, and the meter is deflected in direct proportion to the unbalanced current.

OPERATION AS AN A-C VOLTMETER: (See Figures 1 and 3) The circuit for operation as an a-c voltmeter is as follows: The unknown a-c voltage is applied across the connectors at J-2 and J-3 (ground). The FUNCTION switch applies the voltage to the diode rectifier V-1. The d-c output voltage of V1

is then applied to the voltage divider. A d-c voltage, depending on the RANGE switch setting, is then applied to the grid of d-c amplifier V-2A. The remaining portion of a-c voltmeter operation is the same as the d-c voltmeter operations. The a-c circuit is also used for decibel measurements but the readings are made on the DB scale.

OPERATION AS AN OHMMETER: (See Figures 1 and 3) The circuit for operation as an ohmmeter is as follows: The unknown resistance is connected across connectors J-2 and J-3. The FUNCTION switch connects the range voltage divider and battery B-1 across J-2 and ground. A voltage, depending on the RANGE switch setting, is then applied to the grid of the d-c amplifier V-2A. The remaining portion of the ohmmeter circuit follows the same pattern as the d-c voltmeter circuit.

POWER SUPPLY: (See Figures 1 and 3) The operating potential for the d-c amplifier V-2A is obtained from the full wave rectifier V-3. The B+ output of the rectifier is suitably filtered by R-1, R-2, and C-2. Filament voltages for all tubes are obtained from the 6.3 volt winding of the power transformer T-1.

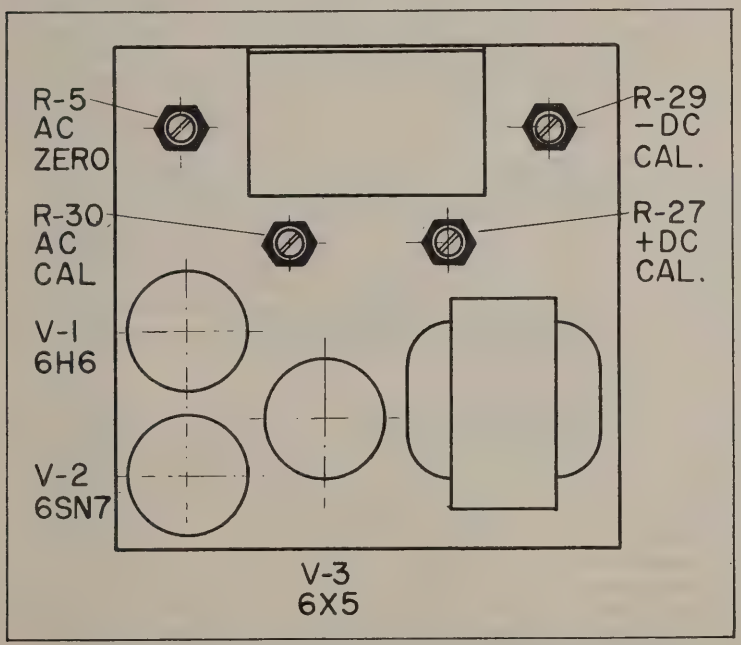


Fig. 2 - Top View of Chassis - Location of calibrating pots.

MAINTENANCE

1. CALIBRATION: After construction of the instrument is completed, it is necessary to carry out the calibration procedure described below.

If a change occurs in the accuracy of the instrument after a long period of use, it is probably due to aging of the components. The accuracy of the instrument may readily be restored by repeating this calibration procedure. Recalibration will also be necessary, whenever parts (tubes, etc.) are replaced.

A. INITIAL STEPS: Follow the procedure described in "INITIAL STEPS" in the OPERATING INSTRUCTIONS section. In addition, check to see that the isolation resistor, R-31, is properly connected within the D-C test probe.

B. D-C VOLTMETER CALIBRATION: (See Fig. 2) To calibrate the d-c voltage ranges, use two flashlight batteries connected in series. The terminal voltage will be 3.10 volts when fresh batteries are used. Set the FUNCTION switch to "-DC" and the RANGE switch to "5V". Short the D-C (red) probe to the COMMON lead (ground) and turn the ZERO ADJ. control until the meter pointer is at zero (ignore any change after the test leads are disconnected). Connect the batteries between the D-C test leads with the COMMON (ground) lead touching the positive side of the batteries. Adjust the "-DC" calibration potentiometer R-29 until a 3.10 volt reading is obtained on the meter (3.10 on the 0 to 5 D-C scale). To calibrate the "+DC" voltage ranges, repeat the above steps with the FUNCTION switch set at "+DC" and the positive end of the cells connected to the D-C probe. Adjust the "+DC" calibration potentiometer R-27.

NOTE: The electrostatic pickup which appears on the low a-c and d-c voltage ranges, when either the AC-OHMS or DC probe is held or touched is normal in a sensitive vacuum tube voltmeter, due to the extreme sensitivity of the instrument. However, if the AC-OHMS or DC probe (depending upon the function) is shorted to the COMMON (ground) lead when the zero adjustment is made, the zero obtained will result in correct meter readings and no error will be introduced because of electrostatic pickup.

C. A-C VOLTMETER CALIBRATION: (See Fig. 2) To calibrate the a-c voltage ranges, set the FUNCTION switch at "AC" and the RANGE switch at "1000V". Short the AC-OHMS (black) test lead to the COMMON lead (ground) and turn the ZERO ADJ. control until the meter pointer is at zero. Turn the RANGE switch to the "5V" position and adjust the A-C shift balance potentiometer, R-5, until the meter pointer returns to zero. Then turn the RANGE switch to the "500V" position; the meter pointer should move very little, usually not at all. Connect the COMMON and AC-OHMS test leads to the 115 volt A-C supply and adjust the A-C calibration potentiometer, R30, until the meter reads 115 volts. Calibration with the 115 volt A-C supply will result in the instrument being accurate within 5%. If greater accuracy is desired, the instrument should be calibrated against a known, standard A-C voltage.

D. OHMMETER CALIBRATION: No separate calibration required.

2. BATTERY REPLACEMENT: When it is no longer possible to adjust the meter pointer to full-scale deflection with the OHMS ADJ. potentiometer, the battery is probably at fault. This battery is a standard 1.5 volt flashlight cell and so may be readily replaced.
NOTE: When replacing the battery, make certain that polarity is observed as shown in the schematic diagram. Recalibration is not required when the battery is replaced.

EICO REPAIR SERVICE

If your instrument fails to function properly and the cause of the trouble is not apparent, you may return it to the EICO repair department where it will be repaired for a nominal charge.

REFERENCES

Carlisle, J. H., "Universal Voltmeter", Radio News, June, '47
Krueger, R. H., "Vacuum-Tube Voltmeter", Radio News, June, '48
Mayo, G., "Vacuum-Tube Voltmeter for A.C. and D.C.", Nov., '43
Parket, A. T., "Get The Most From Your VTVM", Radio Maint., Apr., '48
Rider, J.F., "Vacuum Tube Voltmeters", J.F. Rider Publisher, N.Y.,N.Y., '51
Terman, F. E., "Measurements in Radio Engineering", 1st ed., McGraw-Hill Book Co., N. Y., N. Y., '35, p. 18.

WHEN ORDERING A PART FOR REPLACEMENT, please include the stock number of the part and serial number of your instrument.

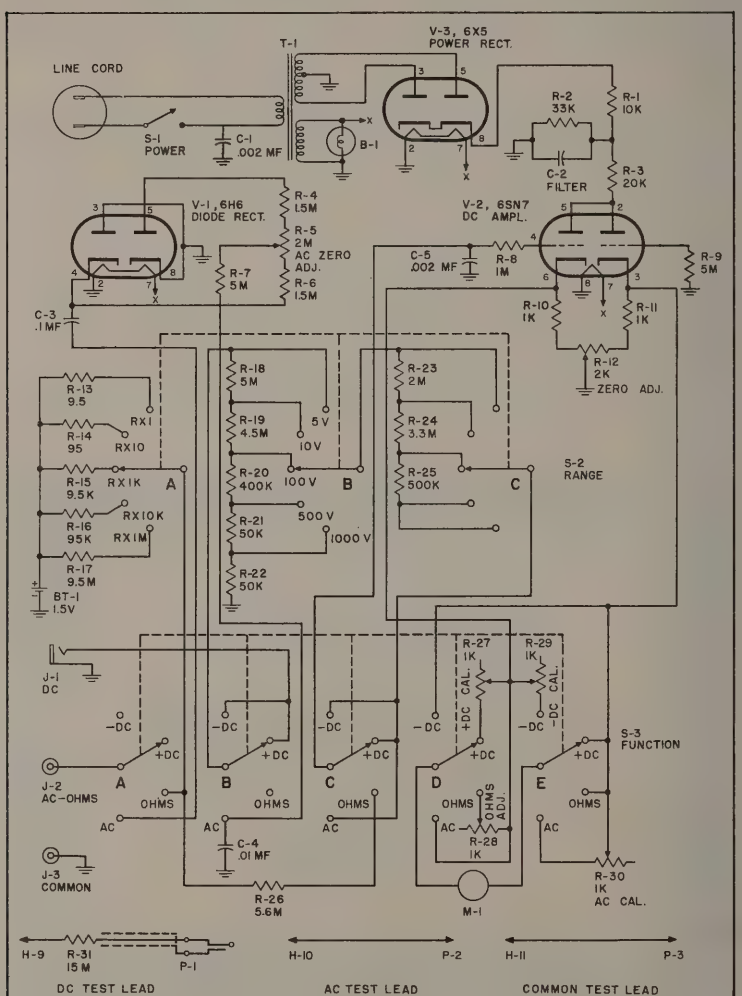


Fig. 3 - Schematic Diagram

PARTS LIST FOR MODEL 221

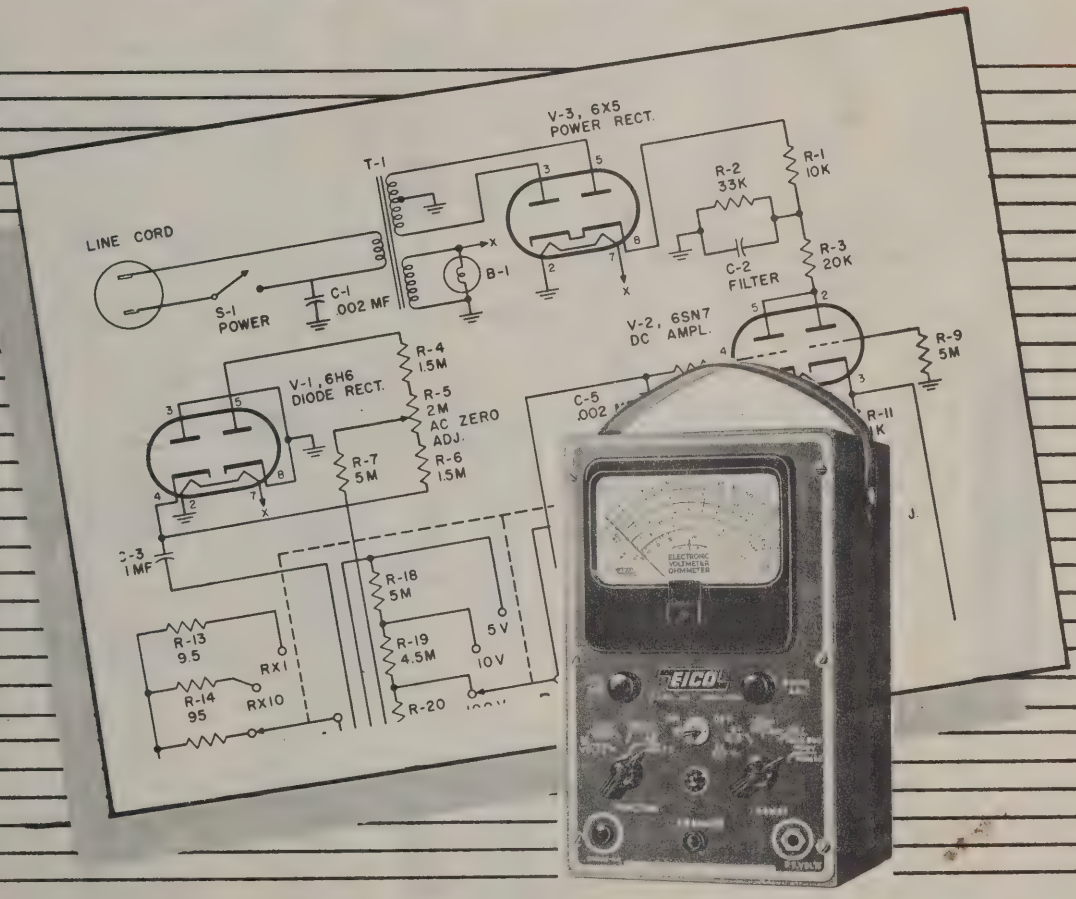
St.#	Sym.	Description	Amt.
100	B1	pilot light	1
101	BT1	1.5 v battery	1
102	C1	.002 mfd cond.	1
103	C2	filter cond.	1
104	C3	.1 mfd cond.	1
105	C4	.01 mfd cond.	1
102	C5	.002 mfd cond.	1
106	H1	panel	1
107	H2	chassis	1
108	H3	cabinet	1
109	H4	handle	1
110	H5	pilot light ass'y	1
111	H6	line cord	1
112	H7	wafer socket	3
113	H8	battery bracket	1
114	H9	red test prod	1
115	H10	black test prod	1
116	H11	alligator clip	1
117	H12	bar knob	2
118	H13	round knob	2
119	H14	3/8" grommet	1
120	H15	1 lug term.strip	1
121	H16	3 lug term.strip	1
122	H17	7/16" nut (S1)	2
123	H18	#6-32 screw	4
124	H19	#6-32 nut	8
125	H20	#10-24 screw	2
126	H21	spaghetti	pc.
127	H22	#6 P.K. screw	7
128	H23	meter lug	2
129	H24	meter nut	2
130	H25	meter washer	4
131	H26	ground lug	5
132	H27	pot ground lug	1
133	H28	1/4" standoff	2
134	H29	#10-24 nut	2
135	H30	3/8" lock washer	10
136	H31	3/8" flat washer	4
137	H32	3/8" hex nut	9
138	H33	wire	roll
139	H34	test lead wire	2
140	H35	shielded wire	pc.
141	H36	#6 lock washer	7
142	H37	bare wire	pc.
143	H38	nut,shldr.washer	1
144	H39	nut, washer	1
145	H40	#6 fibre washer	2
146	J1	phone jack	1
147	J2	pin jack	1
148	J3	banana jack	1
149	M1	meter	1
150	P1	phone plug	1
151	P2	pin plug	1
152	P3	banana plug	1
153	R1	10K ohm res. 2W	1
154	R2	33K ohm res. 2W	1
155	R3	20K ohm res.	1
156	R4	1.5M ohm res.	1
157	R5	2M ohm pot.	1
156	R6	1.5M ohm res.	1
158	R7	5M ohm res.	1
159	R8	1M ohm res.	1
158	R9	5M ohm res.	1
159	R10	1K ohm res.	1
159	R11	1K ohm res.	1
160	R12	2K ohm pot adj	1
161	R13	9.5 ohm 1% res	1
162	R14	95 ohm 1% res.	1
163	R15	9.5K ohm 1% res.	1
164	R16	95K ohm 1% res.	1
165	R17	9.5M ohm 1% res.	1
166	R18	5M ohm 1% res.	1
167	R19	4.5M ohm 1% res.	1
168	R20	400K ohm 1% res.	1
169	R21	50K ohm 1% res.	1
169	R22	50K ohm 1% res.	1
170	R23	2M ohm res.	1
171	R24	3.3M ohm res.	1
172	R25	500K ohm res.	1
173	R26	5.6M ohm res.	1
174	R27	1K ohm pot cal	1
175	R28	1K ohm pot adj	1
174	R29	1K ohm pot cal	1
174	R30	1K ohm pot cal	1
176	R31	15M ohm res.	1
177	S1	SPST switch	1
178	S2	3 pole,5 pos. sw	1
179	S3	6 pole,4 pos. sw	1
180	T1	transformer	1
181	V1	6H6 tube	1
182	V2	6SN7 tube	1
183	V3	6X5 tube	1
184		instruction book	1

Notes: 1) All resistors 1/2 watt unless noted differently. 2) WHEN ORDERING A PART FOR REPLACEMENT, please include the stock number of the part and the serial number of your instrument.

CONSTRUCTION MANUAL

Model 221

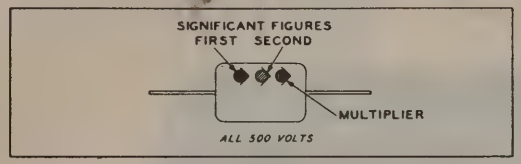
ELECTRONIC VOLT-OHM METER



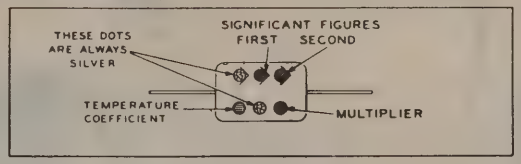
EICO
ELECTRONIC INSTRUMENT CO., Inc. 84 WITHERS STREET, BROOKLYN 11, N. Y.
Reg. U. S. Pat. Off.

CAPACITOR COLOR CODES

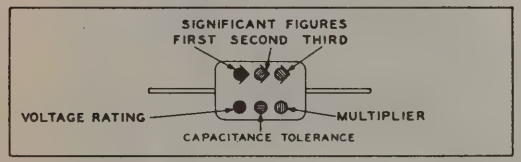
RMA 3-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



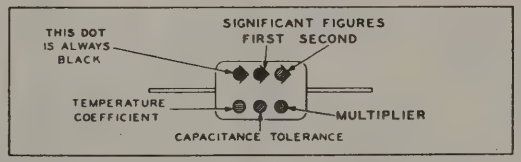
JAN 6-DOT COLOR CODE FOR PAPER-DIELECTRIC CAPACITORS



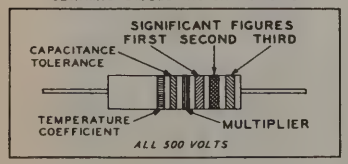
RMA 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



JAN 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS

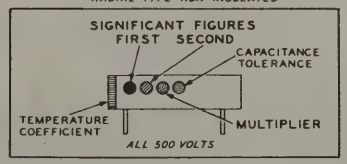


RMA COLOR CODE FOR TUBULAR CERAMIC-DIELECTRIC CAPACITORS

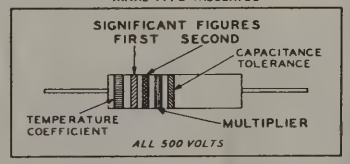


JAN COLOR CODE FOR FIXED CERAMIC-DIELECTRIC CAPACITORS

RADIAL TYPE NON-INSULATED



AXIAL TYPE INSULATED



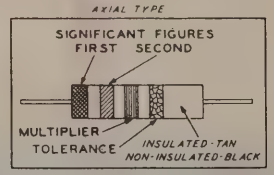
RMA: RADIO MANUFACTURERS ASSOCIATION
JAN: JOINT ARMY-NAVY

RESISTORS				CAPACITORS				
				MULTIPLIER				
TOLERANCE	MULTIPLIER	SIGNIFICANT FIGURE	COLOR	RMA MICA AND CERAMIC-DIELECTRIC	JAN MICA AND PAPER-DIELECTRIC	JAN CERAMIC DIELECTRIC	VOLTAGE RATING	TEMPERATURE COEFFICIENT
	1	0	BLACK	1	1	1		A
	10	1	BROWN	10	10	10	100	B
	100	2	RED	100	100	100	200	C
	1000	3	ORANGE	1000	1000	1000	300	D
	10,000	4	YELLOW	10,000			400	E
	100,000	5	GREEN	100,000			500	F
	1,000,000	6	BLUE	1,000,000			600	G
	10,000,000	7	VIOLET	10,000,000			700	
	100,000,000	8	GRAY	100,000,000		0.01	800	
	1,000,000,000	9	WHITE	1,000,000,000		0.1	900	
5	0.1		GOLD	0.1	0.1		1000	
10	0.01		SILVER	0.01	0.01		2000	
20			NO COLOR				500	

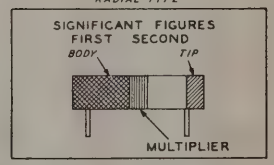
RESISTOR COLOR CODES

RMA COLOR CODE FOR FIXED COMPOSITION RESISTORS

AXIAL TYPE

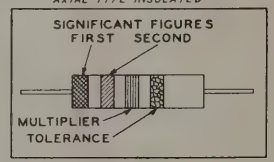


RADIAL TYPE

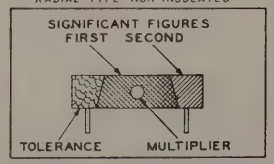


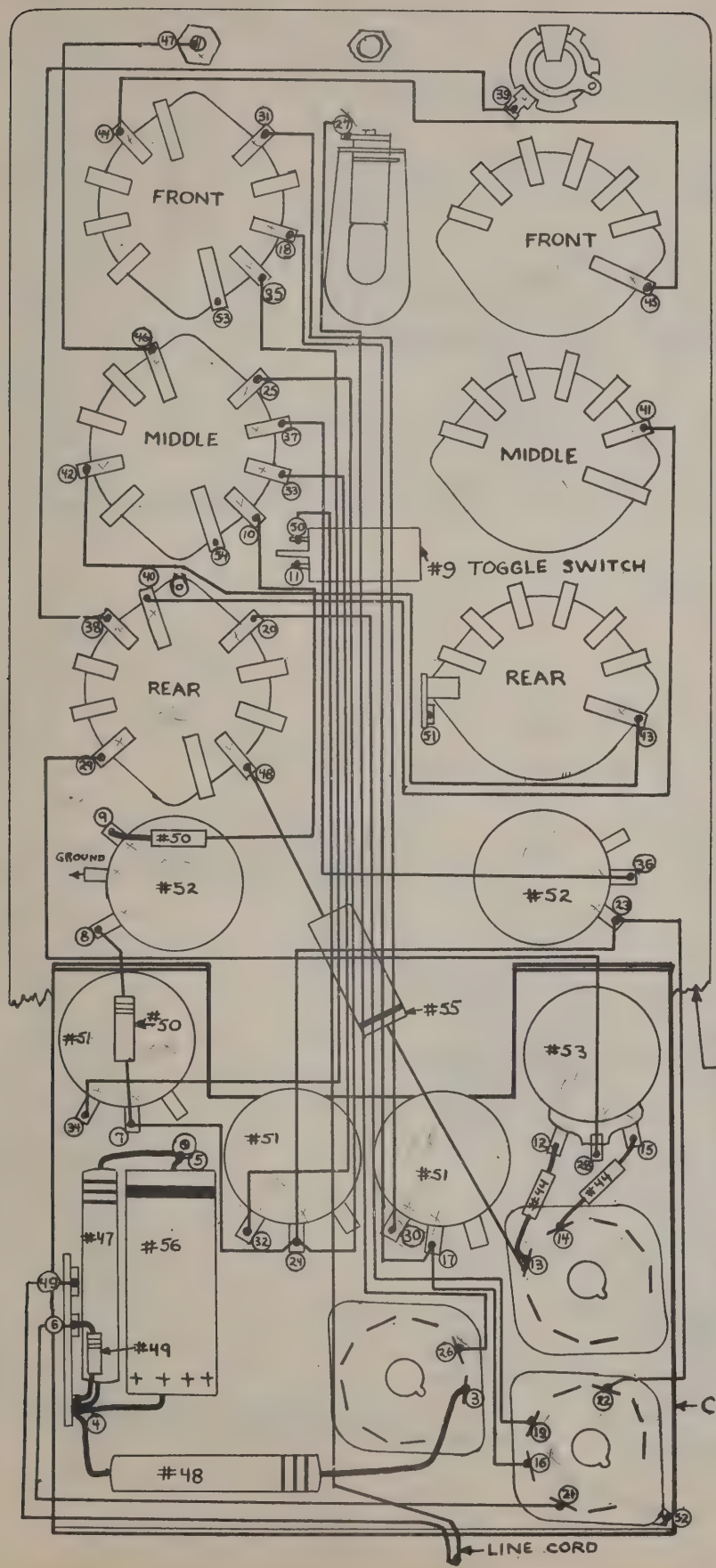
JAN COLOR CODE FOR FIXED COMPOSITION RESISTORS

AXIAL TYPE INSULATED

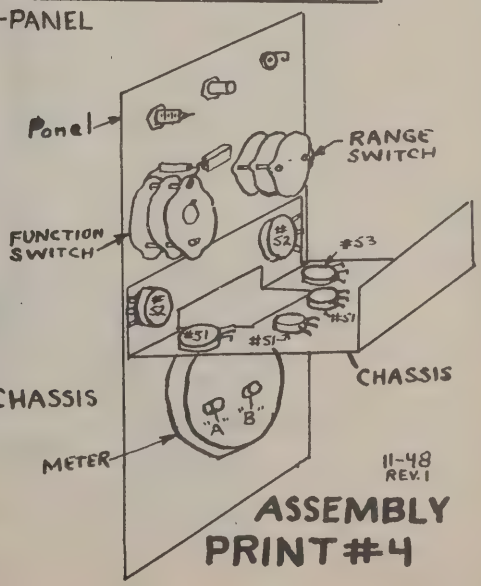


RADIAL TYPE NON-INSULATED



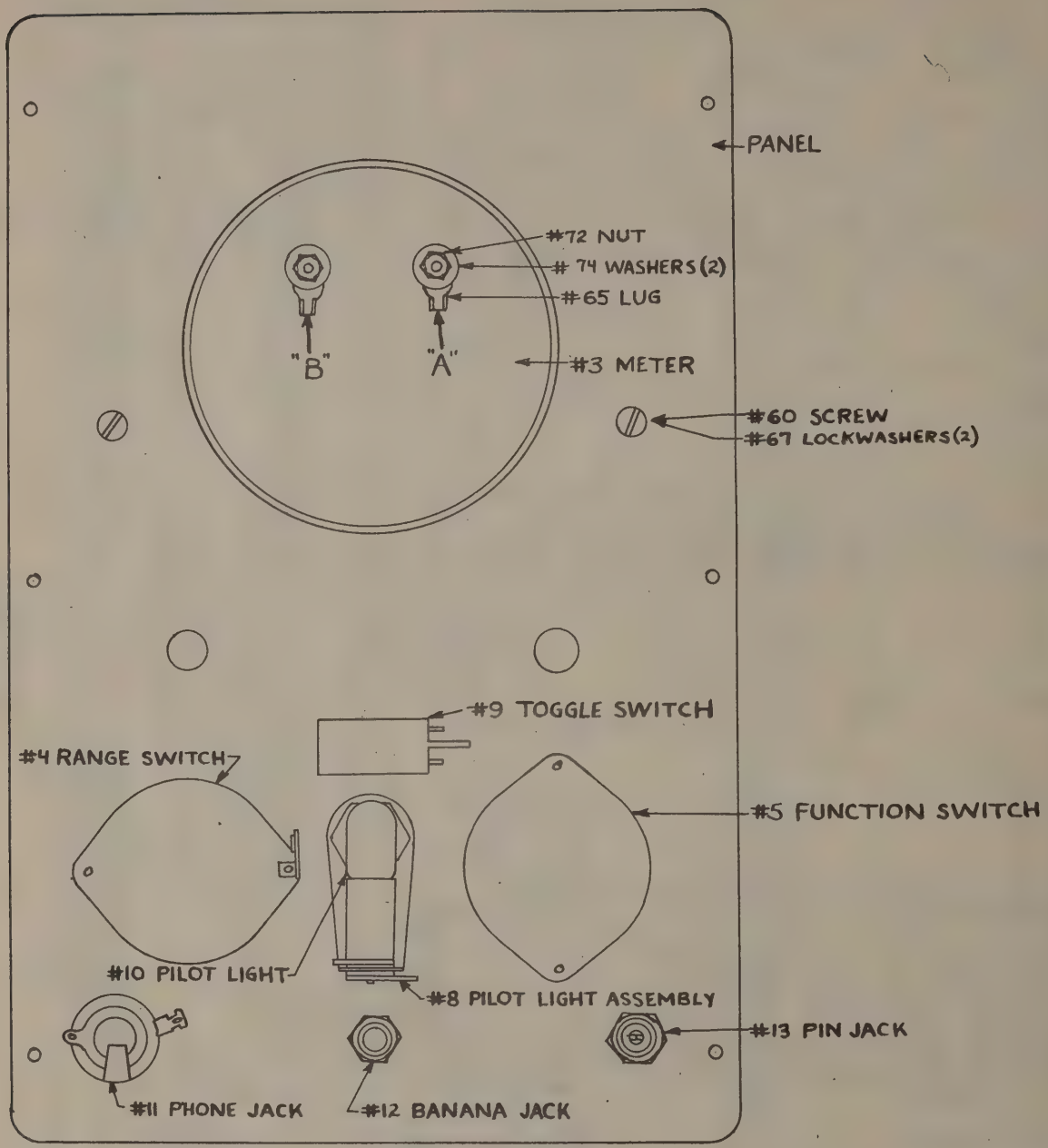


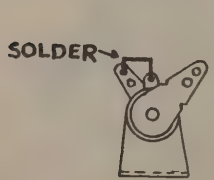
	WIRING		
PART	DESCRIPTION	FROM	TO
48	10K (2W)	3	4
47	33K (2W)	4	5
56	2 MFD COND	4	5
49	20K Ω	4	6
50	1K Ω	7	8
50	1K Ω	9	10
	BLACK WIRE	TRANS.	11
44	1.5 MEG	12	13
44	1.5 MEG	14	15
	WIRE	16	17
	WIRE	17	18
	WIRE	19	20
	WIRE	6	21
	WIRE	22	23
	WIRE	23	24
	WIRE	7	24
	WIRE	24	25
	WIRE	26	27
	WIRE	28	29
	WIRE	30	31
	WIRE	32	33
	WIRE	34	35
	WIRE	36	37
	WIRE	38	39
	WIRE	40	41
	WIRE	42	43
	WIRE	44	45
	BARE WIRE	46	47
55	.01 COND	13	48
	LINE CORD		49
	LINE CORD		50
	WIRE	BATTERY +	51
	WIRE	BAT. −	52
	WIRE	53	METER LUG "A"
	WIRE	54	METER LUG "B"



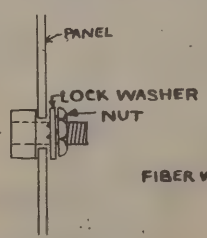
11-48
REV. 1

ASSEMBLY PRINT #4

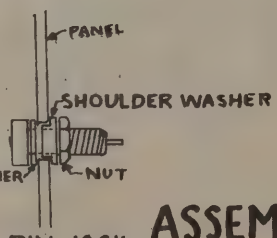




PILOT LIGHT ASSEMBLY



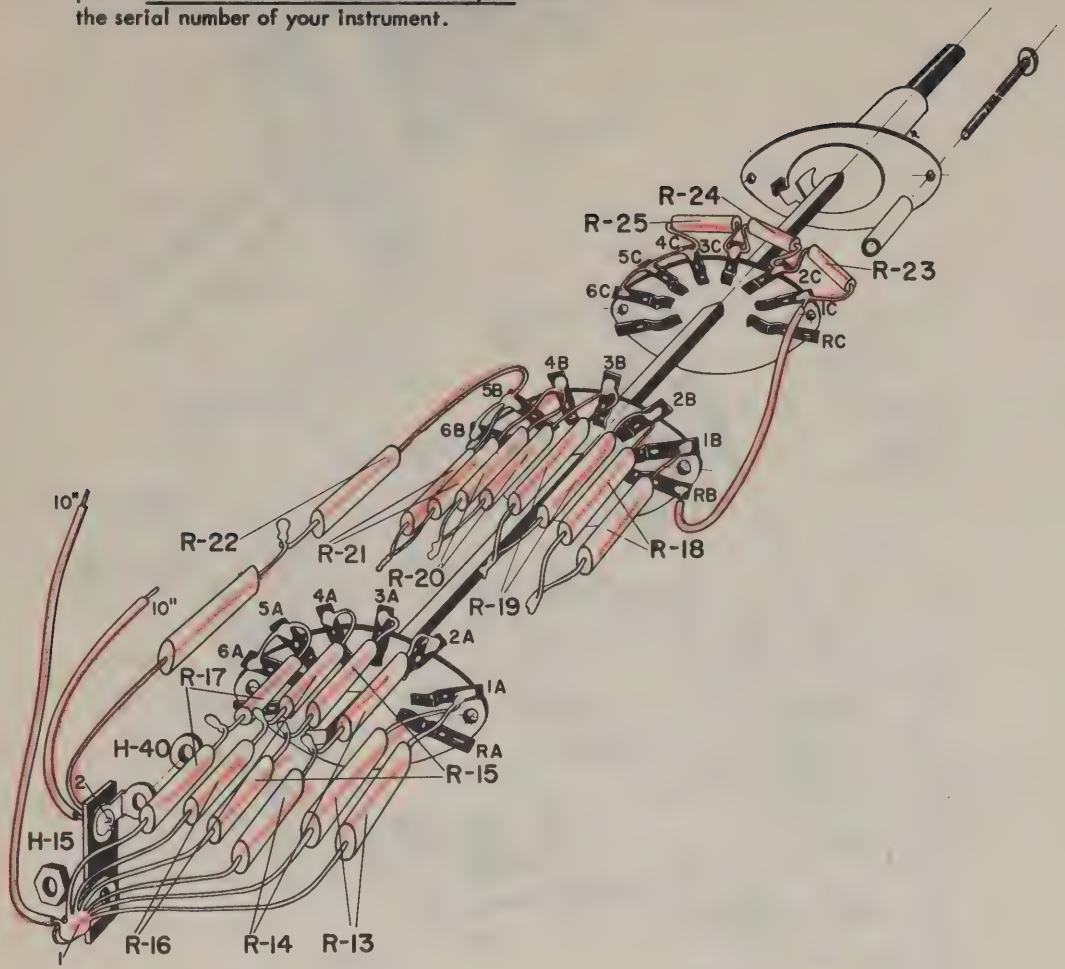
BANANA JACK



PIN JACK

ASSEMBLY PRINT #3

WHEN ORDERING A PART FOR REPLACEMENT, please include the stock number of the part and the serial number of your instrument.



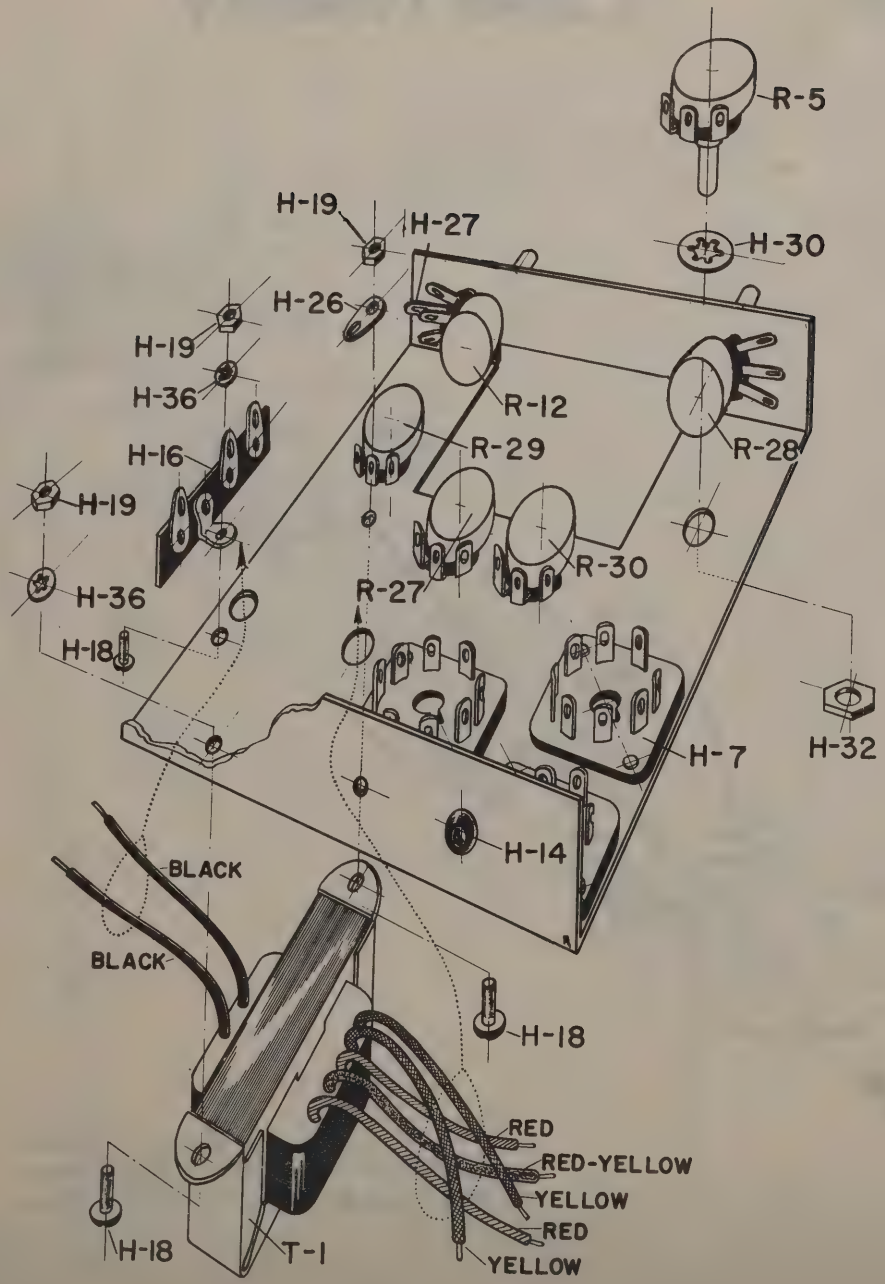
Step #2-1 Assembly: Remove the nut and lockwasher from the switch ass'y. screw (next to 6A). Replace the lockwasher with the #6 fibre washer (H40) and the 1 lug terminal strip (H15). Fasten with the nut previously removed. See drawing.

PREWIRING OF RANGE SWITCH S2

(S) means solder, (C) means connect but do not solder.

✓	Step#	Sym.	Description	From	To (Length)
	2-2	H33	wire	(C) 1C	(S) RB
	2-3	R23	2M ohm res.	(S) 1C	(C) 2C
	2-4	R24	3.3M ohm res.	(S) 2C	(C) 3C
	2-5	R25	500K ohm res.	(S) 3C	(C) 4C
	2-6	H37	bare wire	(S) 4C	(C) 5C
	2-7	H37	bare wire	(S) 5C	(S) 6C
	2-8	R18	5M ohm res.	(C) 1B	(C) 2B
	2-9	R19	4.5M ohm res.	(S) 2B	(C) 3B
	2-10	R20	400K ohm res.	(S) 3B	(C) 4B
	2-11	R21	50K ohm res.	(S) 4B	(C) 5B
	2-12	H37	bare wire	(C) 5B	(S) 6B
	2-13	R22	50K ohm res.	(S) 5B	(C) H15#2
	2-14	R13	9.5 ohm res.	(S) 1A	(C) H15#1
	2-15	R14	95 ohm res.	(S) 2A	(C) H15#1
	2-16	R15	9.5K ohm res.	(S) 3A	(C) H15#1
	2-17	R16	95K ohm res.	(S) 4A	(C) H15#1
	2-18	R17	9.5M ohm res.	(C) 5A	(C) H15#1
	2-19	H37	bare wire	(S) 5A	(S) 6A
	2-20	H33	wire	(S) H15#2	10"
	2-21	H33	wire	(S) H15#1	10"

NOTE: Each of the resistors R13, R14, R15, R16, R17, R18, R19, R20, R21, and R22 is actually a matched pair as shown in the drawing. The two resistors that form a matched pair will be found inserted together in one sleeve marked with the resistance value. All of the matched pairs are to be wired in series except R13, which is wired in parallel. In the case of the series matched pairs, twist two ends together and solder as shown.



The drawing at the left is an exploded view of the chassis mounting. To keep the drawing uncrowded, unnecessary repetition is avoided. For example, the method of mounting is shown only for potentiometer R5, as potentiometers R12, R27, R28, R29, and R30 are mounted in exactly the same way.

MOUNTING TO THE CHASSIS

✓	Step#	Sym.	Description	Mounted With
	3-1	R5	2M ohm pot	1#H30, 1#H32
	3-2	R30	1K ohm pot	1#H30, 1#H32
	3-3	R27	1K ohm pot	1#H30, 1#H32
	3-4	R29	1K ohm pot	1#H30, 1#H32
	3-5	*R12	2K ohm pot	1#H30, 1#H27 1#H32
	3-6	*R28	1K ohm pot	1#H30, 1#H32
	3-7	H16	3 lug term. str.	1#H18, 1#H36 1#H19
	3-8	T1	power xfmr.	2#H18, 2#H19 1#H36, 1#H26
	3-9	H14	3/8 grommet	

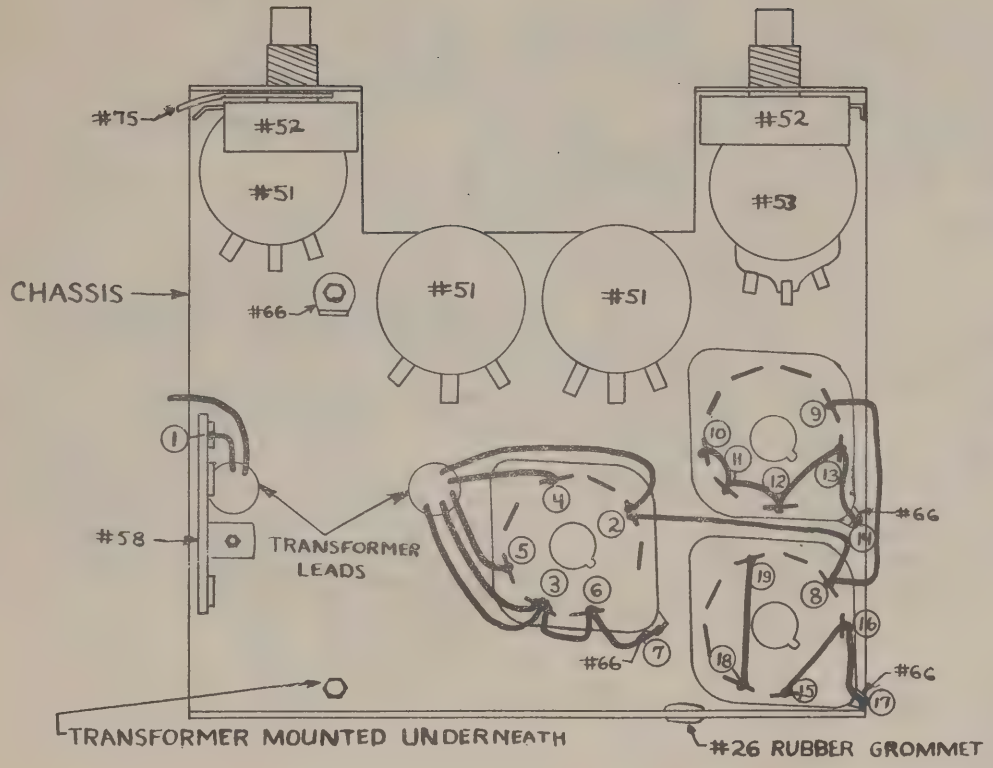
*The 3/8 hex nuts (H32) on the 1K ohm pots (R12 & R28) must be temporarily removed later on to attach the chassis to the panel.

EICO

ASSEMBLY PRINT 3

Model 221

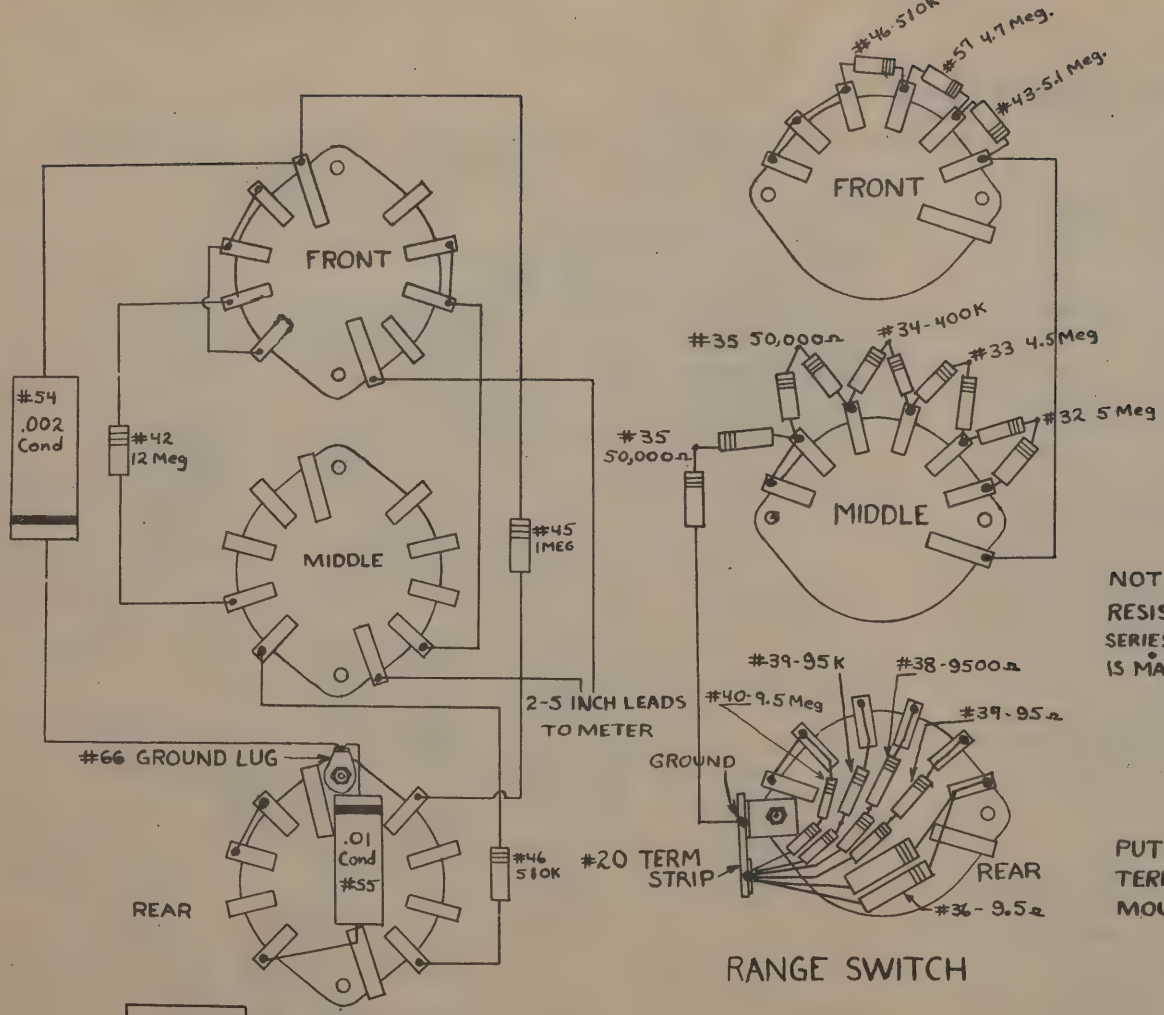
NOTE: SOLDER GROUNDING LUG
#75 TO CENTER LUG OF POT #52



MOUNTING		
PART NO.	DESCRIPTION	HARDWARE
52	1,000Ω pot	1#70 LOCKWASHER
52	1,000Ω pot	1#70, 1#75 LUG
51	1,000Ω pot SCREW SHAFT	1#70, 1#73 NUT
51	1,000Ω pot " "	1#70, 1#73
51	1,000Ω pot " "	1#70, 1#73
53	2 MEG POT	1#70, 1#73
22	TRANSFORMER	2#60 SCREWS 2#61 NUTS 2#67 LOCKWASHERS 1#66 GROUND LUG
58	TERMINAL STRIP	1#60, 1#61, 1#67
26	RUBBER GROMMET	

WIRING			
WIRE	FROM	TO	REMARKS
TRANS. BLACK	TRANS	1	
TRANS. YELLOW	"	2	
TRANS. YELLOW	"	3	
TRANS. RED	"	4	
TRANS. RED	"	5	
TRANS. RED-YEL.	"	3	
BARE	3	6	
BARE	6	7	
BARE	2	8	SPAGETTI
BARE	8	9	SPAGETTI
BARE	10	11	
BARE	11	12	
BARE	12	13	
BARE	13	14	
BARE	15	16	
BARE	16	17	
BARE	18	19	

ASSEMBLY PRINT #1



FUNCTION SWITCH

RANGE SWITCH

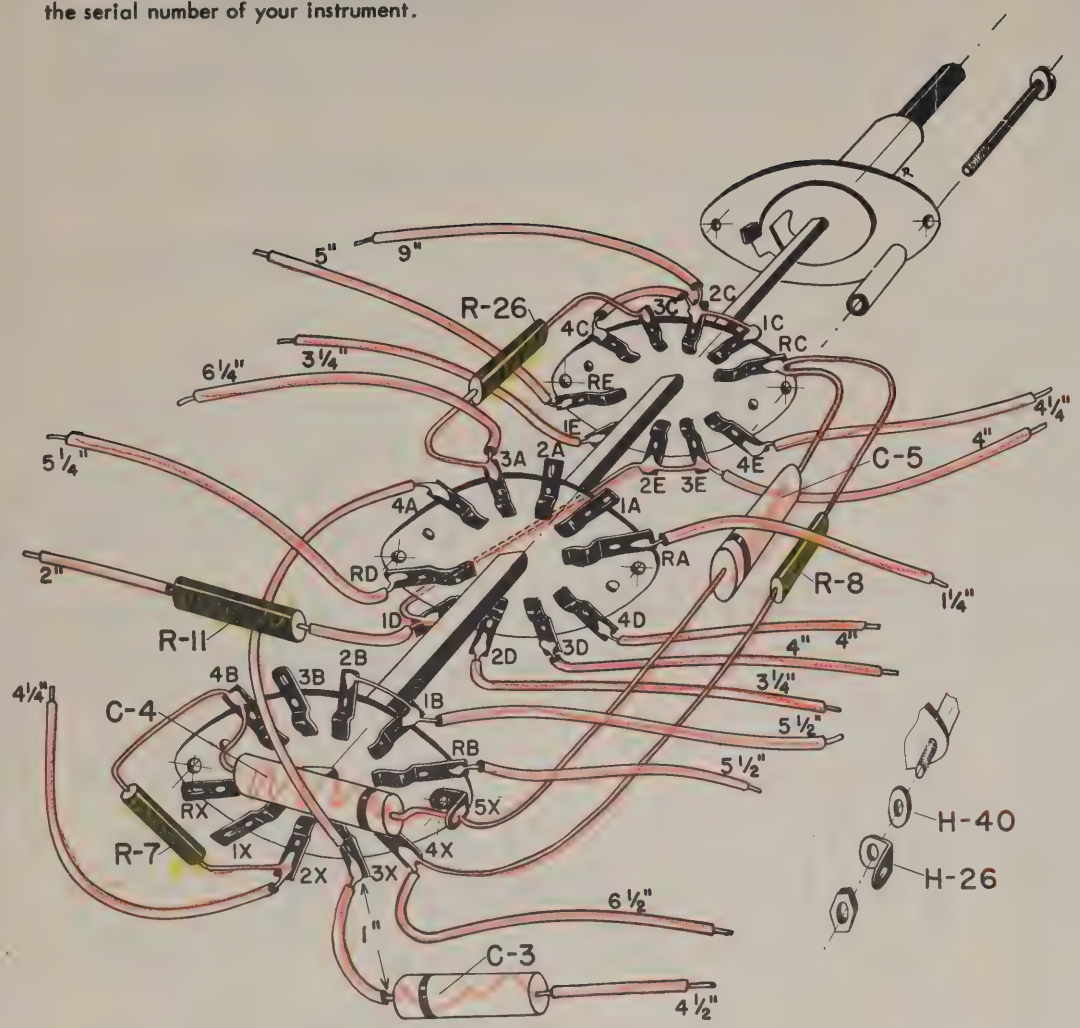
NOTE: ALL MATCHED PAIR RESISTORS ARE MATCHED IN SERIES EXCEPT 9.5 OHMS WHICH IS MATCHED IN PARALLEL.

K=1,000 OHMS
MEG=1,000,000 OHMS

PUT FIBRE WASHER UNDER TERMINAL STRIP WHEN MOUNTING ON RANGE SWITCH

ASSEMBLY PRINT #2

WHEN ORDERING A PART FOR REPLACEMENT, please include the stock number of the part and the serial number of your instrument.



Step #1-1 Assembly: Remove the nut and lockwasher from the switch ass'y. screw (at 5X). Replace the lockwasher with the #6 fibre washer (H40) and the ground lug (H26). Fasten with the nut previously removed. See detail sketch.

PREWIRING OF FUNCTION SWITCH S3

(S) means solder, (C) means connect but do not solder.

Step#	Sym.	Description	From	To (Length)
1-2	C5	.002 mfd cond.	(C) RC	(C) 5X
1-3	R8	1M ohm res.	(S) RC	(C) 4X
1-4	H37	bare wire	(S) 1C	(C) 2C
1-5	H33	wire	(C) 2C	9"
1-6	H33	wire	(S) 2C	(S) 4C
1-7	R26	5.6M ohm res.	(S) 3C	(C) 3A
1-8	H33	wire	(S) RE	5"
1-9	H33	wire	(S) 1E	3 1/4"
1-10	H37	bare wire	(C) 2E	(C) 1D
1-11	H37	bare wire	(S) 2E	(C) 3E
1-12	H33	wire	(S) 3E	4"
1-13	H33	wire	(S) 4E	4 1/4"
1-14	H33	wire	(S) RA	1 1/4"
1-15	H33	wire	(S) 3A	6 1/4"
1-16	H33	wire	(S) 4A	(C) 3X
1-17	H33	wire	(S) RD	5 1/4"
1-18	R11	*1K ohm res.	(S) 1D	2"
1-19	H33	wire	(S) 2D	3 1/4"
1-20	H33	wire	(S) 3D	4"
1-21	H33	wire	(S) 4D	4"
1-22	H33	wire	(S) RB	5 1/2"
1-23	H33	wire	(C) 1B	5 1/2"
1-24	H37	bare wire	(S) 1B	(S) 2B
1-25	C4	.01 mfd cond.	(C) 4B	(S) 5X
1-26	R7	5M ohm res.	(S) 4B	(C) 2X
1-27	H33	wire	(S) 2X	4 1/4"
1-28	C3	*.1 mfd cond.	(S) 3X	4 1/2"
1-29	H33	wire	(S) 4X	6 1/2"

*With spaghetti

EICO

ASSEMBLY PRINT 1 **Model 221**

GENERAL INSTRUCTIONS

1) The Model 221 Electronic Volt-Ohm Meter is constructed very easily with the aid of fully detailed perspective drawings and step-by-step instructions. Before starting the actual construction, it is advisable to study the schematic and pictorial wiring diagrams until all of the steps are clear in your mind. Do not rush the construction, as careful work will result in a properly constructed instrument in the shortest time. In addition, it is suggested that you run all leads exactly as shown on the pictorial wiring diagrams, as this will make the wiring an easier job and insure proper operation of the instrument.

2) USE A GOOD GRADE OF ROSIN CORE SOLDER ONLY. UNDER NO CIRCUMSTANCES USE ACID CORE SOLDER OR ACID FLUX inasmuch as the acid flux can cause serious corrosion. Before soldering, make certain there is a good mechanical connection. The solder must flow before you remove the soldering iron as this will prevent rosin joints which are poor electrical conductors. If you are soldering close to a part, hold the ends of a pair of longnose pliers between the part and the solder joint. The pliers will conduct the heat away and prevent the component from being unduly overheated.

3) Carefully unwrap all the parts and check them in the space provided on the parts list. Note: In order to maintain the supply of kits and insure prompt delivery, we are forced to buy the same component from several sources (standard manufacturers' parts are interchangeable). You may find that the value of a component will vary within the allowable circuit tolerance. This means a resistance of 470,000 ohms may be substituted for, or may measure 510,000 ohms, etc. Any part supplied will work as well as the part for which it was substituted. No substitutions will be made on precision components.

CONSTRUCTION PROCEDURE

For your convenience, the construction of the instrument has been broken down into a logical series of Assembly Prints. Each Assembly Print consists of a detailed drawing and a table of step-by-step instruction so that no step can be overlooked. Space has been provided on the tables to check off each step as it is completed. Follow the order of the Assembly Prints to finish the mechanical assembly and the wiring quickly and easily.

PARTS LIST FOR MODEL 221

St.#	Sym.	Description	Amt.	St.#	Sym.	Description	Amt.	St.#	Sym.	Description	Amt.
100	B1	pilot light	1	130	H25	meter washer	4	158	R9	5M ohm res.	1
101	BT1	1.5 v battery	1	131	H26	ground lug	5	159	R10	1K ohm res.	1
102	C1	.002 mfd cond.	1	132	H27	pot ground lug	1	159	R11	1K ohm res.	1
103	C2	filter cond.	1	133	H28	1/4" standoff	2	160	R12	2K ohm pot adj.	1
104	C3	.1 mfd cond.	1	134	H29	#10-24 nut	2	161	R13	9.5 ohm 1% res.	1
105	C4	.01 mfd cond.	1	135	H30	3/8" lock washer	10	162	R14	95 ohm 1% res.	1
102	C5	.002 mfd cond.	1	136	H31	3/8" flat washer	4	163	R15	9.5K ohm 1% res.	1
106	H1	panel	1	137	H32	3/8" hex nut	9	164	R16	95K ohm 1% res.	1
107	H2	chassis	1	138	H33	wire	roll	165	R17	9.5M ohm 1% res.	1
108	H3	cabinet	1	139	H34	test lead wire	2	166	R18	5M ohm 1% res.	1
109	H4	handle	1	140	H35	shielded wire	pc.	167	R19	4.5M ohm 1% res.	1
110	H5	pilot light ass'y	1	141	H36	#6 lock washer	7	168	R20	400K ohm 1% res.	1
111	H6	line cord	1	142	H37	bare wire	pc.	169	R21	50K ohm 1% res.	1
112	H7	wafer socket	3	143	H38	nut, shldr. washer	1	169	R22	50K ohm 1% res.	1
113	H8	battery bracket	1	144	H39	nut, washer	1	170	R23	2M ohm res.	1
114	H9	red test prod	1	145	H40	#6 fibre washer	2	171	R24	3.3M ohm res.	1
115	H10	black test prod	1	146	J1	phone jack	1	172	R25	500K ohm res.	1
116	H11	alligator clip	1	147	J2	pin jack	1	173	R26	5.6M ohm res.	1
117	H12	bar knob	2	148	J3	banana jack	1	174	R27	1K ohm pot cal.	1
118	H13	round knob	2	149	M1	meter	1	175	R28	1K ohm pot adj.	1
119	H14	3/8" grommet	1	150	P1	phone plug	1	174	R29	1K ohm pot cal.	1
120	H15	1 lug term. strip	1	151	P2	pin plug	1	174	R30	1K ohm pot cal.	1
121	H16	3 lug term. strip	1	152	P3	banana plug	1	176	R31	15M ohm res.	1
122	H17	7/16" nut (S1)	2	153	R1	10K ohm res. 2W	1	177	S1	SPST switch	1
123	H18	#6-32 screw	4	154	R2	33K ohm res. 2W	1	178	S2	3 pole, 5 pos. sw.	1
124	H19	#6-32 nut	8	155	R3	20K ohm res.	1	179	S3	6 pole, 4 pos. sw.	1
125	H20	#10-24 screw	2	156	R4	1.5M ohm res.	1	180	T1	transformer	1
126	H21	spaghetti	pc.	157	R5	2M ohm pot.	1	181	V1	6H6 tube	1
127	H22	#6 P.K. screw	7	156	R6	1.5M ohm res.	1	182	V2	6SN7 tube	1
128	H23	meter lug	2	158	R7	5M ohm res.	1	183	V3	6X5 tube	1
129	H24	meter nut	2	159	R8	1M ohm res.	1	184		instruction book	1

Notes: 1) All resistors 1/2 watt unless noted differently. 2) WHEN ORDERING A PART FOR REPLACEMENT, please include the stock number of the part and the serial number of your instrument.

The needle should move very little, usually no movement at all. Connect the common and AC test leads to the 115 volt AC line and adjust the AC calibration potentiometer until the scale reads 115 volts. This is usually within 5% and sufficient for service work. If greater accuracy is desired, the instrument should be calibrated against a known AC standard voltage.

To check the ohms scale, set the function switch on ohms and adjust the zero adjust potentiometer with the leads shorted. Unshort the leads and set the needle on the last line past the 1000 mark on the ohms scale with the ohms adjust potentiometer. The ohmmeter is ready for use. If the ohms adjust potentiometer will not bring the needle past the last mark on the scale, try a higher gain 6SN7 or a new battery. If neither of the above will do, put two batteries in series.

To use meter scales: Because of the linearity of AC diode rectification, the same scale is used for both AC and DC reading. The top half of the AC-DC scale is used for 5 volt readings and the lower half for 10 volt readings. To use the 500 volt scale, use the top scale and add two zero's to the reading. Thus read 5 and add two zero's to make it 500. To use the 100 volt scale, use the 10 volt scale and add one zero. To use the 1000 volt scale use the 10 volt scale and add two zero's to the reading.

To use the ohmmeter, read the top scale directly and multiply by the number of zero's (e.g. Rx1, Rx100, etc.) shown on the range switch.

The db meter is calibrated for a 600 ohm load with a reference level of 1.0 multiwatt. To use, set the function switch to AC and the range switch to 5 volts. Read decibels directly on DB scale. To measure higher levels, turn the range switch to a higher setting, read decibels on scale and add to this reading the factor listed below.

10 V Range add -/ 6db, 100 V Range add -/ 26 db, 500 V add -/ 40 db, 1000V add -/ 46 db

If you have trouble

1. Check wiring carefully. Most cases of trouble result from wrong or reversed wiring.
2. Check tubes and battery. (See that DC isolation resistor (R1) is in DC Probe).
3. If pointer swings to right on /DC and cannot be brought back, the grid circuit ingluding the range switch may be open.
4. Check voltages on tubes. The 6SN7 plate voltage should be about 85 volts and the cathode voltage about 3.5 volts.
5. Check DC probe carefully to make sure shielding is not shorting the wire. Check jacks for shorting to ground
6. If you are unable to obtain satisfactory results, write the engineering department, giving all information possible, voltages obtained, any indications on meter, etc., which will help diagnosing the trouble.

7. If desired, your instrument may be returned to the factory. It will be put in operating condition for a charge of $4.00 plus any parts or alterations required due to damaged or improper construction. Pack well and mark fragile. Ship prepaid. Instrument will be returned as soon as possible.

The assembly of the vacuum tube voltmeter is not difficult, and if care if used, no trouble should be encountered. First unpack all the parts, checking them against the parts list, identifying each one to make sure no parts are thrown away with the packing. Standard manufacturers values may be interchangeable etc. We are forced to order from several sources in order to assure the supply of these kits. You may therefore find that a value may vary within the permissable circuit tolerance, e.g., a resistance of 470,000 may be substituted or may measure 510,000 etc. All parts supplied will work just as well as the part for which it is substituted. Most parts have a tolerance rating of 20% and the circuit is designed to take these variations into account.

The tools needed for the work are a cleaned and tinned soldering iron, screwdrivers, pliers, and side cutters. Use a good grade of rosin cored solder. Do not use acid core solder or flux. When making connections, wrap the wire securely around the joint and then solder, making sure solder flows into the joint.

Before starting the actual construction, study the schematic and pictorial wiring diagrams thoroughly, getting all the steps clear in your mind. Do not rush the assembly. Care will pay dividends. When this kit is completed, it will represent a fine piece of laboratory test equipment. Most troubles in building kits can be traced to wrong connections or reversed parts and poor soldering.

Mount the parts of the chassis first, using lock washers under all potentiometers. The calibration potentiometers have screwdriver slots in the shafts, while the adjust potentiometers going on the panel do not. Mount the transformer on the top of the chassis after mounting terminal strip 58. Wire as shown. Be sure to solder grounding lug #75 to center arm of potentiometer 52.

Now assemble the function and range switches. Many troubles encountered in the assembly have occured in wiring these switches. Some difficulties are the result of poor soldering connections. Use care to prevent rosin from running on to the contacts as this will result in erratic operation. Trace out the wiring with a colored pencil to make sure you have left out no connections. When mounting the ground lug on the function switch, make sure it does not touch the wafer terminals. Matched (or single) 1% Precision resistors are supplied in the VTVM for all multipliers. These will be found in a paper sleeve with the value indicated on the sleeve. Do not separate these resistors. They are to be soldered together either in series (parts #32 to 35 and 37 to 40) or parallel (part #36) as per assembly print #2. All paired resistors are matched to within 1% accuracy and care should be taken not to over heat them. Carbofilm single 1% resistors may be used insted of the matched pairs and are equally good.Use each carbofilm resistor instead of a pair. After building the switches, they should be carefully cleaned with generous amounts of carbon tetrachloride.

Mount the panel as shown on assembly print 3. Tighten the banana jack well, as it is a ground connection. Mount the panel flush to the chassis by fastening it with the nuts. Put flat washers under the nuts to keep from marring the panel. Wire the unit as shown in assembly print 4. Watch the polarity of the electrolytic condenser. When the instrument is completed, the wiring should be carefully checked. In this way, any connections overlooked or incorrect, will be disclosed.

Plug the line cord into 110 volt 60 cycle AC current. Set selector switch to +DC volts, and turn instrument on. To insure maximum accuracy, the tubes should be aged. Preliminary calibration can be made after a warm up period of approximately 30 minutes. However, final calibration should be made after aging the tubes. This can be done by leaving the instrument on for 48 hours or by using it for several weeks. After final calibration is made against known accurate voltages (described below), apply glue to the base of the calibration potentiometer to prevent jarring them out of place. The instrument should then not vary from calibration unless tubes are changed.

In switching ranges, a change in the zero setting of the meter pointer will be observed. A small amount of this (not more than two fractional divisions on the voltage scales) is normal and will decrease as the tubes are aged. Some 6SN7 and 6H6 tubes however, are sufficiently unbalanced to cause a great deal more change. If possible, these should be exchanged for other tubes locally, as they are entirely satisfactory for radio use, but not for VTVM use. These tubes should not be returned, as they are guaranteed only as good for radio use.

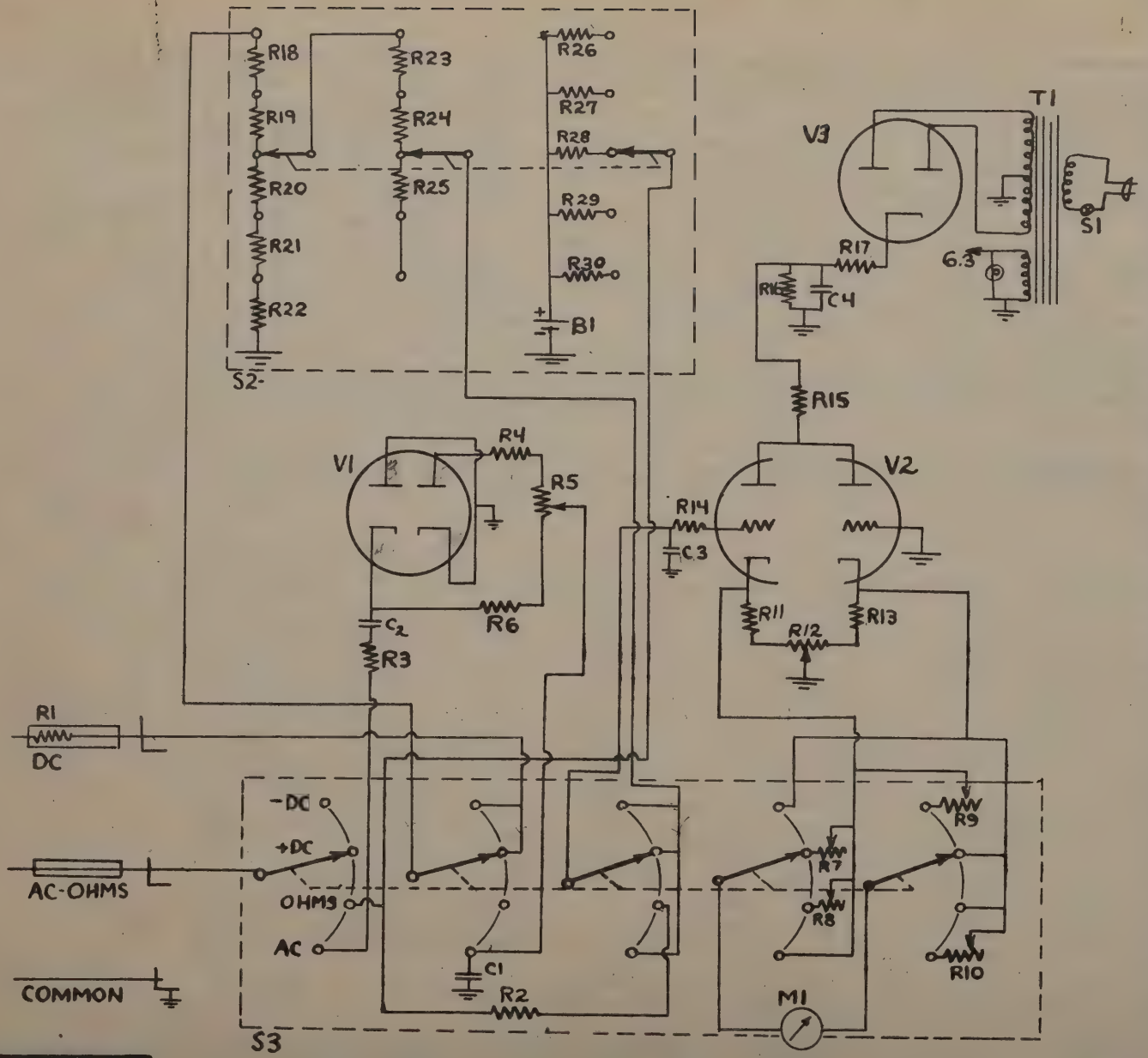
Before turning the instrument on to calibrate, set meter needle to zero with the set screw on bakelite meter case. In this way, the needle will stay on zero when switching from plus to minus DC. Be sure (R1) isolation resistor is in DC (red) probe.

To calibrate DC, use two flashlight cells in series. This adds up to a total of 3.10 volts when fresh. Put the function switch on -DC and the range switch on 5v. Short the DC lead to ground and adjust zero control until meter reads exactly zero (ignore any change after test leads are disconnected). Put batteries between the ground clip and DC test lead with the ground clip touching the positive side of the battery. Adjust the -DC calibration potentiometer to read 3.10 volts on the 5 volt scale. To calibrate the +DC, repeat the above steps with the function on +DC and the battery positive touching the DC lead. Adjust the +DC potentiometer. The electrostatic pick up which appears when the AC or DC lead is held or touched is normal in sensitive VTVM, and is due to the extreme sensitivity of the instrument. When the lead is grounded, and zero adjusted, the actual zero will remain correct for meter readings. No error is introduced because of this pick up.

To calibrate AC, set function switch to AC and range switch to 1000 volts. Short AC test lead to ground or to common test lead. Set meter needle on zero with zero adjust knob. Turn range switch to 5 volt position. Turn the AC zero shift balance potentiometer until the needle returns to zero. Turn the range switch to 500 volts.

PARTS LIST

1. Panel.....1
*2. Chassis assembly.....1
3. Meter.....1
4. Range switch.....1
5. Function switch.....1
6. Cabinet.....1
7. Handle.....1
8. Pilot light assembly.....1
9. SPST toggle switch.....1
10. Pilot light.....1
11. Phone jack.....1
12. Banana jack.....1
13. Pin jack.....1
14. Banana plug.....1
15. Phone plug.....1
16. Phone tip.....1
17. Test prod (black).....1
18. Test prod (red).....1
19. Alligator clip.....1
20. 1 lug terminal strip.....1
*21. Wafer sockets.....3
22. Transformer.....1
23. 6X5 tube.....1
24. 6SN7 tube.....1
25. 6H6 tube.....1
26. Rubber grommet.....1
27. Battery bracket.....1
28. 1.5v battery.....1
29. Bar knobs.....2
30. Round knobs.....2
31. Line cord.....1
32. 5 meg 1% resistor matched pair.....1
33. 4.5 meg ohm 1% matched pair.....1
34. 400,000 ohm 1% matched pair.....1
35. 50,000 ohm 1% matched pair.....2
36. 9.5 ohm 1% matched pr.....1
37. 95 ohm 1% matched pr.....1
38. 9,500 ohm 1% matched pr..1
39. 95,000 ohm 1% matched pair.....1
40. 9.5 meg ohm 1% matched pair.....1
41. 15 meg ohm BTS resistor..1
42. 11 meg or 12 megohm resistor.....1
43. 5 megohm resistor.....1
44. 1.5 megohm resistor.....2
45. 1 megohm resistor.....1
46. 510,000 ohm resistor.....2
47. 33,000 ohm 2w resistor...1
48. 10,000 ohm 2w resistor...1
49. 20,000 ohm resistor.....1
50. 1,000 ohm resistor.....2
51. 1,000 ohm pot screwdriver shaft (calibrate).....3
52. 1,000 ohm pot (adjust)...2
53. 2 meg pot.....1
54. .002 condenser.....1
55. .01 condensers.....2
56. 2mfd. 250v condenser.....1
57. 4.7 megohm resistor.....1
58. 3 lug terminal strip.....1
59. standoff ¼" for handle...2
60. 6/32-¼ screws.....6
61. 6/32 nuts.....4
62. 10/24-3/8 button head screw.....2
63. 10/24 nuts.....2
64. #6-¼" "A" PK screws.....7
65. Meter lugs.....2
*66. Ground lugs.....5
67. Lock washers, small #6...5
68. Fibre washers.....2
69. Roll wire.....1
70. 3/8" lock washer, lge....8
71. 3/8" flat washer , panel.....4
72. 10/32 nut brass (meter)..2
73. 3/8 nuts.....10
74. Brass washers (meter)....4
75. Control grounding lug....1
76. AC & common test lead wire 48" strip.....2
77. Shielded wire 48" (DC test lead).....1
78. Instruction book.....1

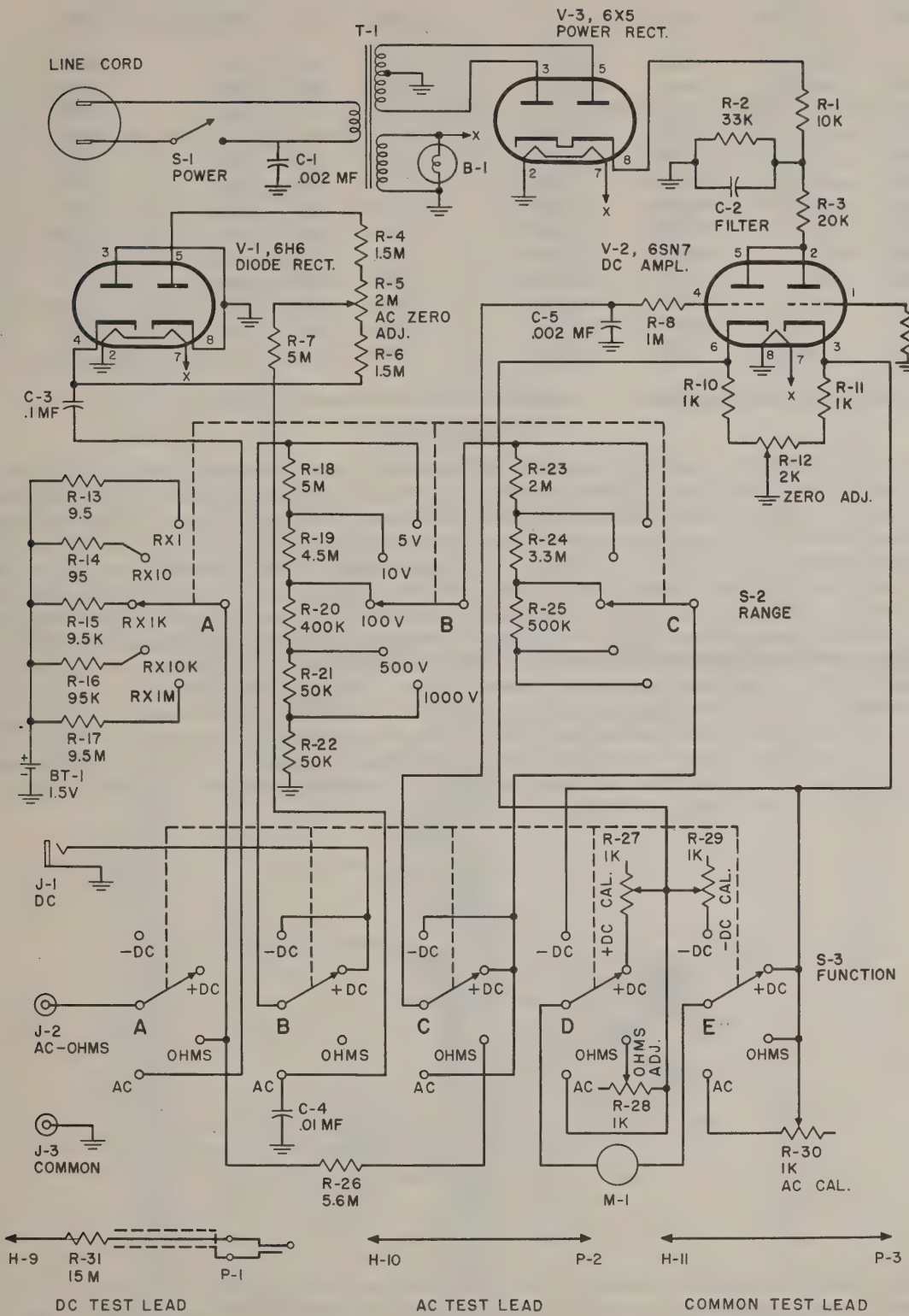


ITEM	PART	SPECIFICATION
R1	41	15 MEG. RES.
R2	42	12 MEG. RES.
R3	46	500,000Ω
R4	44	1.5 MEGOHM
R5	53	2 MEG AC ZERO POT
R6	44	1.5 MEGOHM
R7	51	1K +D.C. CAL. POT
R8	52	1K OHMS ADJ. POT
R9	51	1K -DC CAL. POT
R10	51	1K AC CAL. POT
R11	50	1,000Ω BTS
R12	52	1K ZERO ADJ. POT
R13	50	1,000Ω BTS
R14	45	1 MEGΩ BTS
R15	49	20,000Ω
R16	47	33,000Ω 2W
R17	48	10,000Ω 2W
R18	32	5 MEGΩ 1%
R19	33	4.5 MEGΩ 1%
R20	34	400,000Ω 1%
R21	35	50,000Ω 1%
R22	35	50,000Ω 1%
R23	43	5 MEGΩ BTS
R24	57	4.7 MEGΩ BTS
R25	46	500,000Ω BTS
R26	36	9.5Ω 1%
R27	37	95Ω 1%
R28	38	9500Ω 1%
R29	39	95,000 1%
R30	40	9.5 MEGΩ 1%
C1	55	.01 CONDENSER
C2	55	.01 COND.
C3	54	.002 COND.
C4	56	2MFD COND.
V1	25	6H6 TUBE
V2	24	6SN7 TUBE
V3	23	6X5 TUBE
T1	22	TRANSFORMER
M1	3	0-1 MA. METER
B1	28	1.5 VOLT BATTERY
S1	9	ON-OFF SWITCH
S2	4	RANGE SWITCH
S3	5	FUNCTION SWITCH

EICO

MODEL 221 - CIRCUIT DIAGRAM

11-48
REV. 1


T-1
V-3, 6X5
POWER RECT.
LINE CORD
S-1
POWER
C-1
.002 MF
B-1
R-2
33K
R-1
10K
C-2
FILTER
R-3
20K
V-1, 6H6
DIODE RECT.
R-4
1.5M
R-5
2M
AC ZERO
ADJ.
R-6
1.5M
R-7
5M
V-2, 6SN7
DC AMPL.
C-5
.002 MF
R-8
1M
R-9
5M
R-10
1K
R-11
1K
R-12
2K
ZERO ADJ.
C-3
.1 MF
R-13
9.5
R-14
95
R-15
9.5K
R-16
95K
R-17
9.5M
BT-1
1.5V
RX1
RX10
RX1K
RX10K
RX1M
A
R-18
5M
R-19
4.5M
R-20
400K
R-21
50K
R-22
50K
5 V
10 V
100 V
500 V
1000 V
B
R-23
2M
R-24
3.3M
R-25
500K
C
S-2
RANGE
J-1
DC
J-2
AC-OHMS
J-3
COMMON
-DC
+DC
OHMS
AC
C-4
.01 MF
R-26
5.6M
R-27
1K
R-29
1K
+DC CAL.
-DC CAL.
D
E
OHMS ADJ.
R-28
1K
M-1
S-3
FUNCTION
R-30
1K
AC CAL.
H-9
R-31
15 M
P-1
H-10
P-2
H-11
P-3
DC TEST LEAD
AC TEST LEAD
COMMON TEST LEAD

FINAL MOUNTING AND WIRING

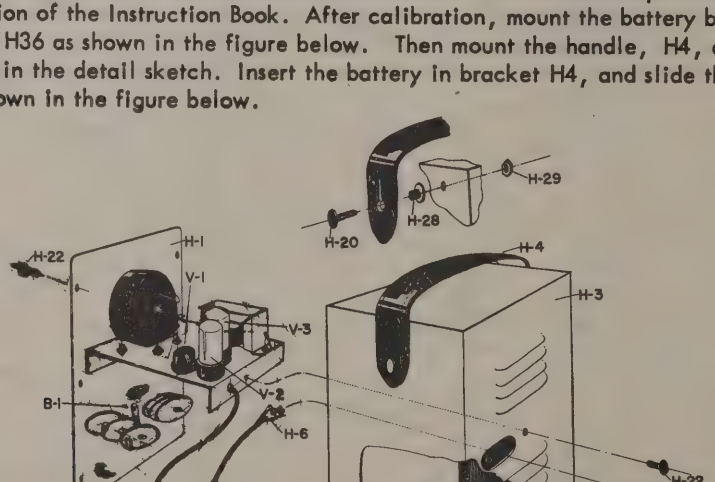
✓	Step#	Sym.	Description	From	To
	7-1	T1	power xfmr.	black	(S) S1#1
	7-2	H6	line cord	lead	(S) S1#2
	7-3	**Mount switch S3 with 1#H30, 1#H31, 1#H32			
	7-4	H33	wire	*S3#3E	(S) R30#2
	7-5	H33	wire	*S3#4E	(S) R30#1
	7-6	H33	wire	*S3#4X	(S) V2#4
	7-7	H33	wire	*S3#4D	(S) R27#2
	7-8	H33	wire	*S3#2D	(S) R27#1
	7-9	H33	wire	*S3#3D	(S) R28#2
	7-10	H33	wire	*S3#1E	(S) R29#1
	7-11	H33	wire	*S3#2X	(S) R5#2
	7-12	C3	.1 mfd cond.	*S3#3X	(S) V1#4
	7-13	R11	1K ohm res.	*S3#1D	(S) R12#1
	7-14	H33	wire	*S3#1B	(S) J1
	7-15	H33	wire	*S3#RA	(S) J2
	7-16	H33	wire	*S3#RE	(S) M1#1
	7-17	**Mount switch S2 with 1#H30, 1#H31, 1#H32			
	7-18	H33	wire	*S3#2C	(S) S2#RC
	7-19	H33	wire	*S3#RD	(S) M1#2
	7-20	H33	wire	*S3#3A	(S) S2#RA
	7-21	H33	wire	*S3#RB	(S) S2#1B
	7-22	H33	wire	*H15#1	(S) BT1#1
	7-23	H33	wire	*H15#2	(S) BT1#2
	7-24	H37	bare wire	(S) H5#2	(S) H5#3
	7-25	H33	wire	*V3#7	(S) H5#1
	7-26	Knob Placement - Instructions on Ass'y. Print 5			

*Connection soldered previously. **Mount to panel as shown on Ass'y. Print 5.

FINAL STEPS

You have now completed the mechanical assembly and the wiring of your instrument. Insert the tubes and the pilot light as shown in the figure below. Check the wiring carefully for errors or omissions. If you have an ohmmeter, measure the resistance from V3, pin 8 to ground (before connecting the instrument to the power line). If it is less than 40,000 ohms, check the rectifier circuit. Insert the plug on the line cord into the 115 VAC power supply and turn the instrument on. If you have a voltmeter, check to see if you have the following voltages to ground (within 20%): V2, pins 2 & 5 — 90 v; V2, pin 3 — 3 to 4 v; V2, pin 6 — 3 to 4 v. If these voltages are not present, check the wiring and components in the circuits involved. Whether you have made the voltage and resistance checks or not, proceed with these remaining steps. Check to see that rotation of the "ZERO ADJ." potentiometer results in movement of the meter pointer. Set the FUNCTION switch at "OHMS" and observe whether the meter pointer swings to the right as it should. Check to see whether the "OHMS ADJ." potentiometer can adjust the meter pointer to full-scale deflection.

After you have made these checks, proceed with the calibration. The calibration procedure is described completely in the MAINTENANCE section of the Instruction Book. After calibration, mount the battery bracket, H8, on the cabinet with 2#H18, 2#H19, and 2#H36 as shown in the figure below. Then mount the handle, H4, on the cabinet with 2#H20, 2#H28, and 2#H29 as shown in the detail sketch. Insert the battery in bracket H4, and slide the chassis into the cabinet, securing it with 7#H22 as shown in the figure below.

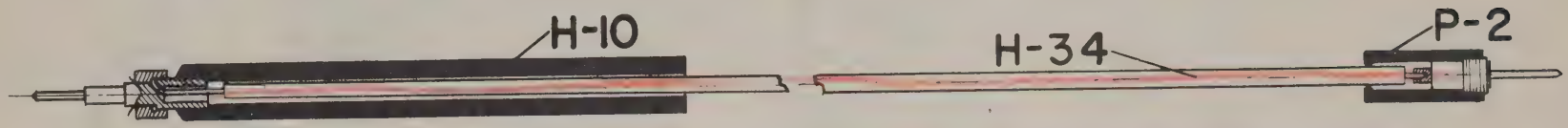


If the instrument fails to operate properly, make certain that the wiring and the components in the circuit are correct. Almost all troubles reported to us in the past, have had improper wiring as their cause. If the wiring is correct, test for continuity and check individual components for breakdown. If you are still having difficulty, write to our engineering department (Electronic Instrument Co., Inc., 84 Withers Street, Brooklyn 11, New York) listing all indications which might be helpful. The serial number of your instrument should be included in any correspondence. If desired, you may return the instrument to our factory, where it will be placed in operating condition and calibrated for $4.00 plus the cost of parts replaced due to their being damaged in the construction of the instrument. Pack the unit very carefully; in the original shipping carton, if possible. Send it to the above address, prepaid Railway Express. The instrument will be returned as soon as possible, express collect.

DC TEST LEAD

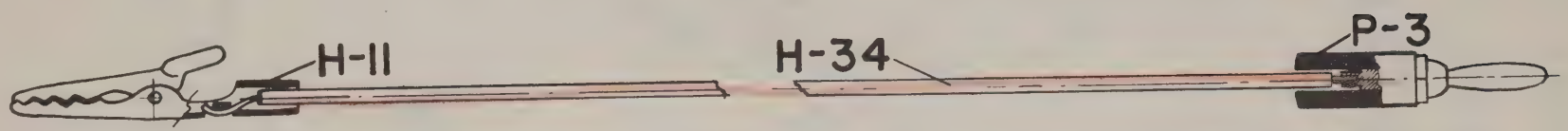
Strip ends of shielded wire, H35, as shown. Solder one end of inner conductor to 15M ohm resistor, R31. Be sure that shielding is well separated from exposed inner conductor. Unscrew ring nut from tip of test prod, H9. Slide cable through prod, resistor first, until resistor lead protrudes from small hole in prod tip. Wind protruding lead once around tip and secure with ring nut. Unscrew cover from phone plug, P1, and slide other end of the shielded wire through it. Solder inner conductor to short terminal lug of P1. Insert exposed shielding in clamp at the end of the long terminal. Crimp it so that the cable is held securely. Solder shielding to clamp. Make sure that shielding is well separated from exposed end of inner conductor. Slide cover to end of plug and screw tight.

AC TEST LEAD



Strip ends of test lead wire, H34. Remove ring nut from black test prod, H10. Slide wire through prod until one stripped end protrudes from small hole in prod tip. Wind exposed wire around prod tip and secure with ring nut. Unscrew cover from pin plug, P2, and slide other end of wire through it. Solder end of wire to terminal on pin plug. Slide cover to end of plug and screw tight.

COMMON TEST LEAD

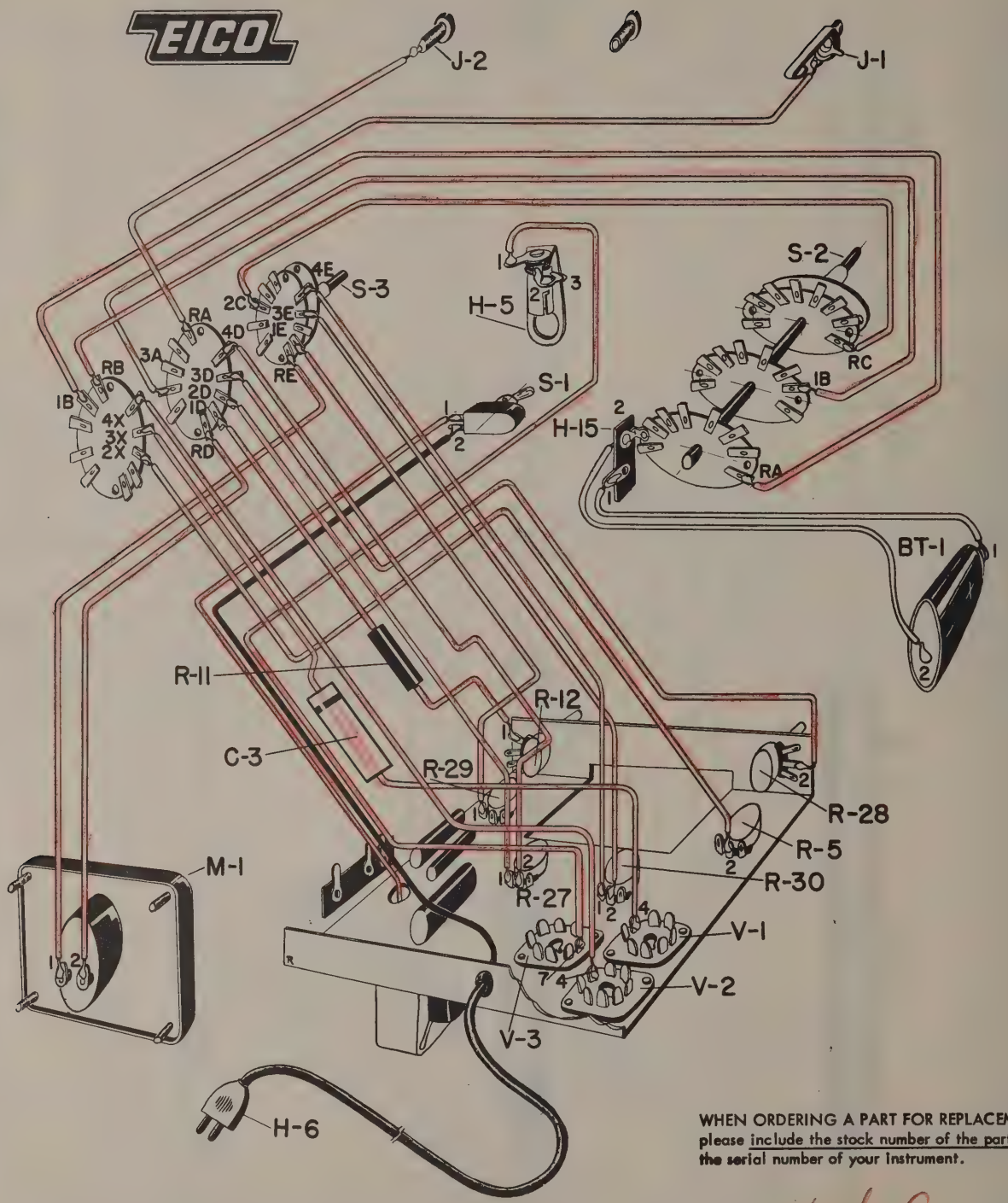


Strip ends of test lead wire, H34. Solder one end to alligator clip, H11. Unscrew cover from banana plug, P3, and slide other end of wire through it. Solder end of wire to terminal on banana plug. Slide cover to end of plug and screw tight.

OK Stan

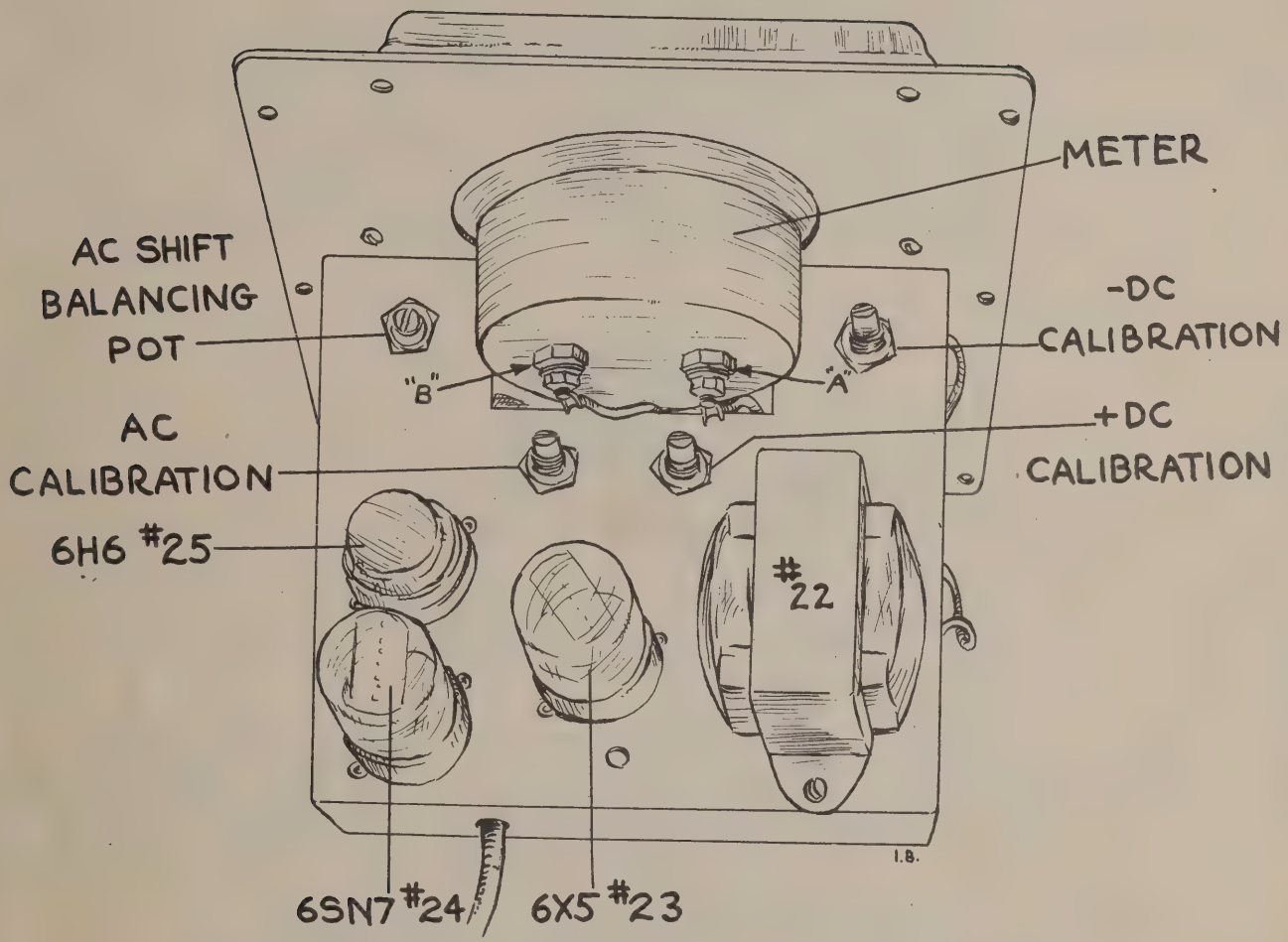
ASSEMBLY PRINT 7

Model 221



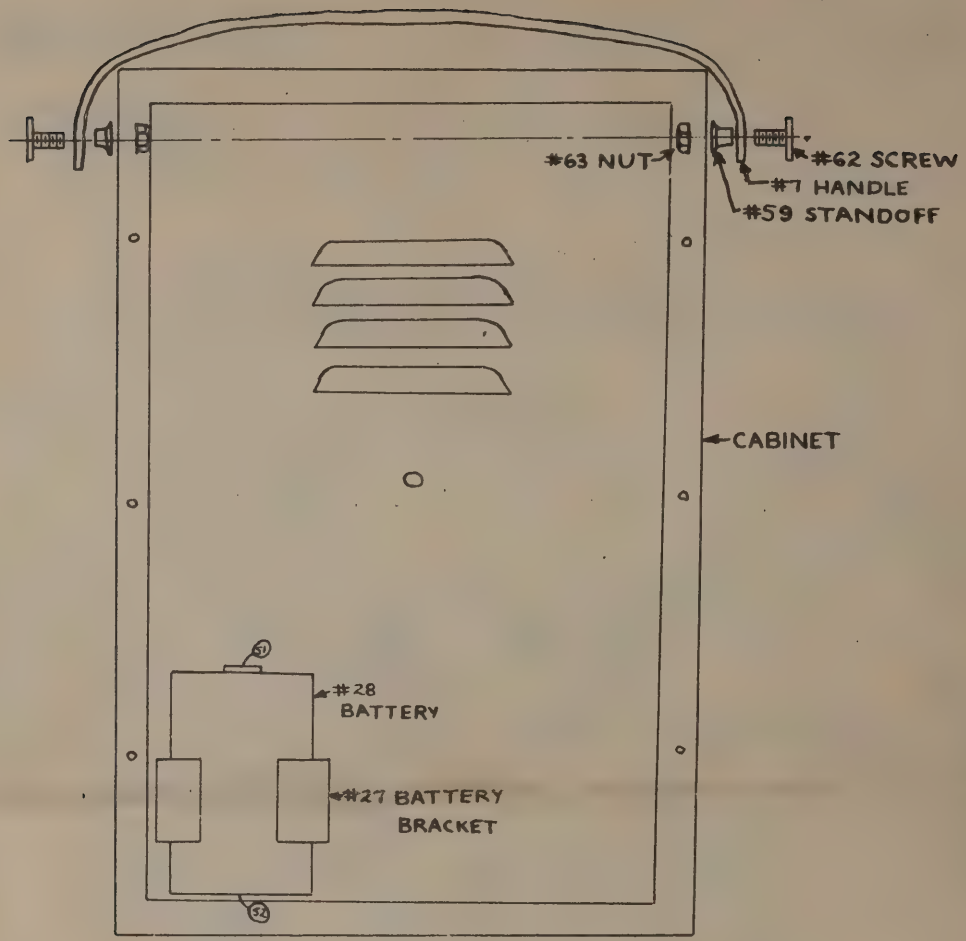
WHEN ORDERING A PART FOR REPLACEMENT, please include the stock number of the part and the serial number of your instrument.

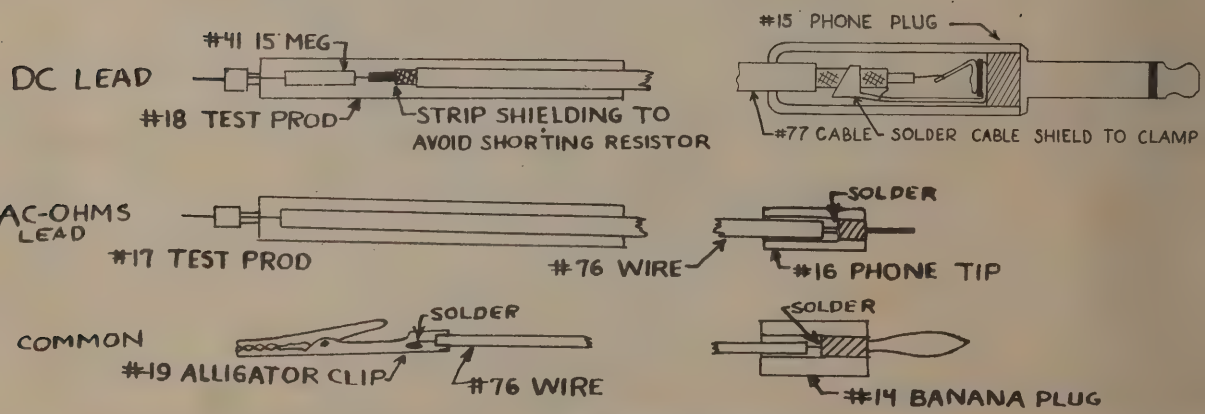
O K Sleeve



TOP VIEW

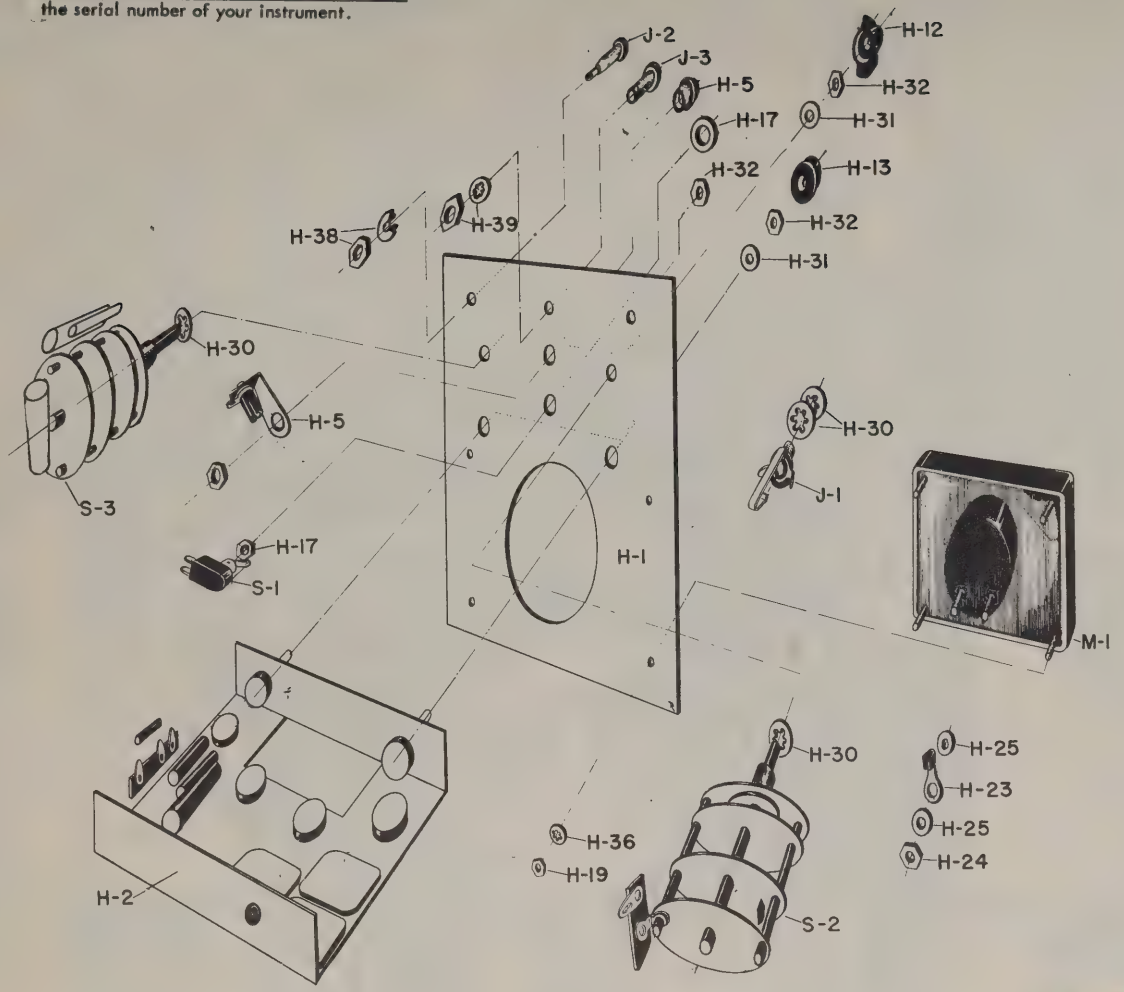
ASSEMBLY PRINT #6





ASSEMBLY PRINT #5

WHEN ORDERING A PART FOR REPLACEMENT, please include the stock number of the part and the serial number of your instrument.



MOUNTING ON PANEL*

✓	Step #	Sym.	Description	Mounted With
	5-1	H5	pilot light	associated hdwre.
	5-2	J2	pin jack	1#H38 nut & shldr. washer
	5-3	J3	banana jack	1#H39 nut & lock washer
	5-4	S1	SPST toggle switch	2#H17
	5-5	J1	phone jack	2#H30, 1#H32
	5-6	M1	meter movement	4#H36, 4#H19
	5-7	H23	meter lugs	4#H25, 2#H24
	5-8	H2	chassis	2#H31, 2#H32**

*For convenience in wiring, switches S2 and S3 are mounted later.
**3/8 hex nuts previously mounted - remove temporarily and replace after the pot shafts are through the panel.

KNOB PLACEMENT - STEP #7-26

(To be done after switches S2 and S3 have been mounted as part of "FINAL MOUNTING AND WIRING", the table accompanying Assembly Print 7).

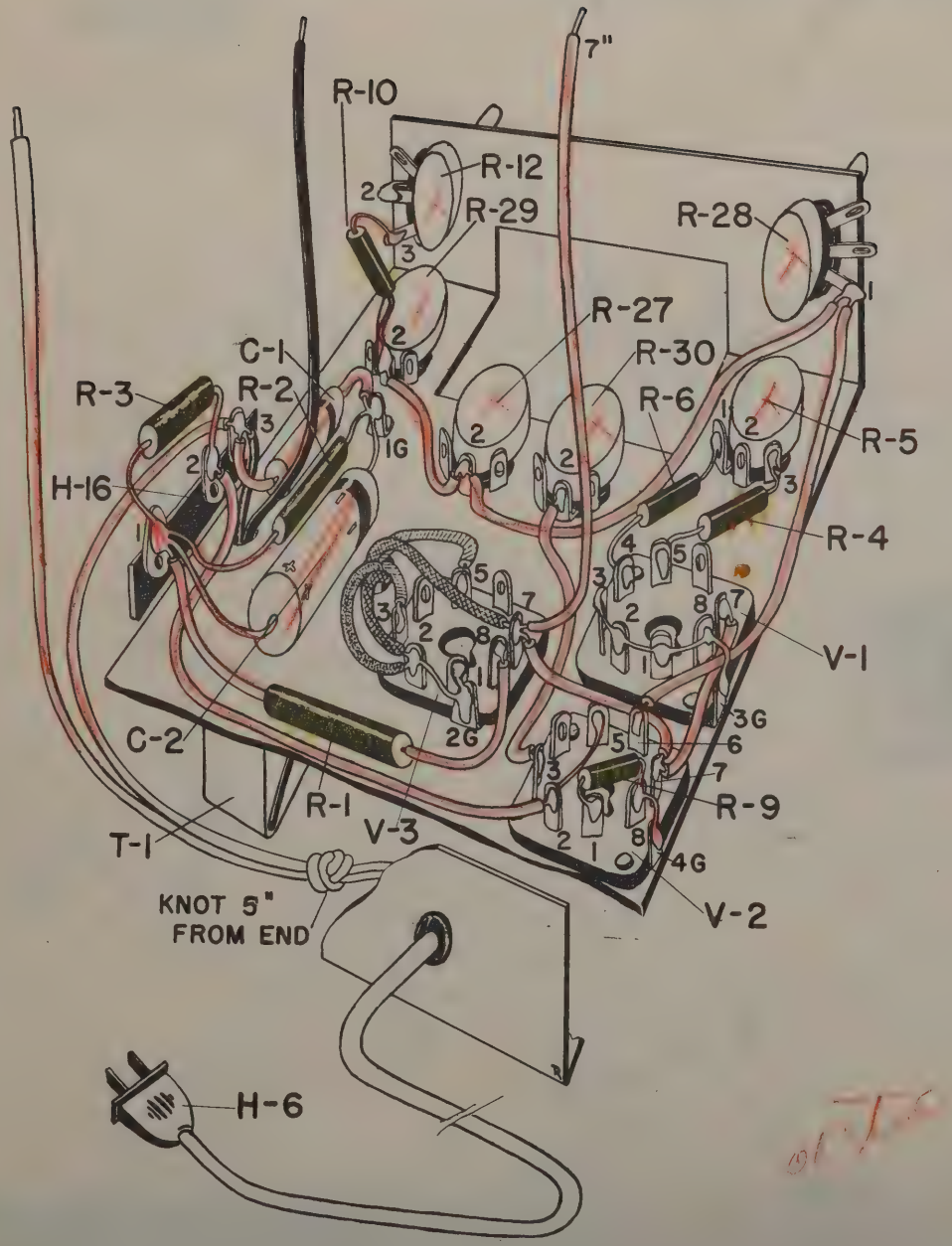
Place the small round knobs (H13) on the shafts of the OHMS ADJ. and ZERO ADJ. potentiometers respectively, and tighten the set screws.

Place the bar knobs (H12) on the shafts of the FUNCTION switch, S3, and the RANGE switch, S2, and tighten the set screws. Rotate the switches counter-clockwise as far as they will go. Loosen the set screws, and line up the FUNCTION switch and RANGE switch knobs with the markers for the "-DC VOLTS" and "5V, RX1" positions respectively. Tighten the set screws. The knobs now indicate properly.

EICO

ASSEMBLY PRINT 5

Model 221



CHASSIS WIRING

(S) means solder, (C) means connect but do not solder.

✓	Step#	Sym.	Description	From	To (Length)
✓	4-1	H33	wire	(C) H16#2	(C) V2#2
✓	4-2	H37	*bare wire	(S) V2#2	(S) V2#5
✓	4-3	T1	red wire	T1	(S) V3#3
✓	4-4	T1	red wire	T1	(S) V3#5
✓	4-5	T1	red-yellow wire	T1	(C) V3#2
✓	4-6	T1	yellow wire	T1	(C) V3#2
✓	4-7	H37	bare wire	(S) V3#2	(C) 2G
✓	4-8	H37	bare wire	(S) V3#1	(S) 2G
✓	4-9	T1	yellow wire	T1	(C) V3#7
✓	4-10	H33	wire	(C) V3#7	(C) V2#7
✓	4-11	H33	wire	(S) V3#7	7"
✓	4-12	H33	wire	(S) V2#7	(S) V1#7
✓	4-13	H37	bare wire	(S) V1#3	(C) V1#2
✓	4-14	H37	bare wire	(S) V1#2	(C) V1#1
✓	4-15	H37	bare wire	(S) V1#1	(C) V1#8
✓	4-16	H37	bare wire	(S) V1#8	(S) 3G
✓	4-17	R4	1.5M ohm res.	(S) V1#5	(S) R5#3
✓	4-18	R6	1.5M ohm res.	(S) R5#1	(C) V1#4
✓	4-19	H33	wire	(S) V2#6	(C) R28#1
✓	4-20	H33	wire	(S) R28#1	(C) R27#2
✓	4-21	H33	wire	(S) V2#3	(C) R30#2
✓	4-22	R10	*1K ohm res.	(S) R12#3	(C) R29#2
✓	4-23	H33	wire	(S) R29#2	(C) R27#2
✓	4-24	R9	5M ohm res.	(S) V2#1	(C) V2#8
✓	4-25	H37	bare wire	(S) V2#8	(S) 4G
✓	4-26	R3	20K ohm res.	(S) H16#2	(C) H16#1
✓	4-27	R1	*10K ohm res.	(S) V3#8	(C) H16#1
✓	4-28	T1	black wire	T1	(C) H16#3
✓	4-29	C1	.002 mfd cond.	(C) H16#3	(C) 1G
✓	4-30	R2	*33K ohm res.	(C) H16#1	(C) 1G
✓	4-31	C2	*filter cond.	(S) H16#1	(S) 1G
✓	4-32	H6	line cord (1 lead)		(S) H16#3
✓	4-33	H27	pot grounding lug		(S) R12#2

*With spaghetti

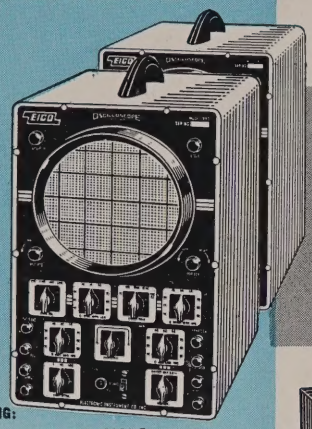
EICO

ASSEMBLY PRINT 4
Model 221

New! 7 INCH PUSH-PULL OSCILLOSCOPE

Only EICO Has All These Features:

- **VERTICAL FREQ. RESPONSE:** flat ± 2 db 10 cps — 1 mc
- **VERTICAL SENS.:** .01 volts rms/inch
- **HOR. FREQ. RESP.:** flat ± 0 db 10 cps — 200 kc, —4 db at 500 kc
- **HOR. SENS.:** .3 volts rms/inch
- **SWEEP RANGE:** 15 cps-100 kc
- **3-STEP FREQ.-COMPENSATED ATTENUATOR** eliminates freq. distortion, overloading.
- **CATHODE FOLLOWER** inputs to both amplifiers
- **PUSH-PULL** outputs in both amplifiers
- **RETURN TRACE BLANKING**
- **INT. VOLTAGE CALIBRATOR**
- **V & H TRACE EXPANSION & CENTERING:** 1.5X full screen without distortion.
- **DIRECT CONNECTION** to vert. CRT plates.
- **PHASING CONTROL** of internal 60 cps sine wave sweep.
- **AT FRONT PANEL:** intensity mod. input; 60 cps, sawtooth outputs.



MODEL 470K
KIT $79.95. WIRED $129.50.

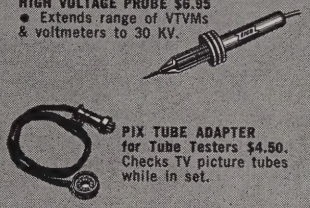
Also Available:
425K 5" PUSH-PULL SCOPE KIT $44.95. WIRED $79.95.

- AC & DC volts: 0-5, 10, 100, 500, 1000 V (30 KV with HVP-1 probe).
- 5 ohm ranges from .2 ohm to 1000 megs.
- DC input Z 26 megs.
- 4½" meter movement in can't-burn-out circuit.
- 1% mult. resistors.

221K VTVM KIT $25.95. WIRED $49.95.

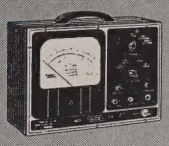
- Covers all TV & FM freqs. between 500 kc & 228 mc in continuous sweep.
- Sweep width variable 0-30 mc.
- Crystal marker oscillator, variable amplitude.

360K SWEEP GEN. KIT $34.95. WIRED $49.95.



HIGH VOLTAGE PROBE $6.95
- Extends range of VTVMs & voltmeters to 30 KV.

PIX TUBE ADAPTER for Tube Testers $4.50. Checks TV picture tubes while in set.



- Large 7½" meter, can't-burn-out circuit.
- AC/DC volts: 0-5, 10, 100, 500, 1000 (30 KV with HV Probe).
- 5 ohms ranges from .2 ohm to 1000 megs.
- DC input Z 26 megs.
- 1% mult. resistors.

214K VTVM KIT $34.95. WIRED $54.95.

- Illum. gear-driven "Speed Rollchart."
- New lever-action switches for individual testing of every element.
- Tests all conventional & TV tubes.

625K TUBE TESTER KIT $34.95. WIRED $49.95.

- Measures & tests all resistors; .5 ohm to 500 megohms.
- Every type condenser, 10 mmf to 5000 mfd.
- 0-500 DC voltage source for capacitor leakage testing.

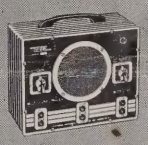
950A-K R-C BRIDGE & R-C-L COMP. KIT $19.95. WIRED $29.95.

NOW! ONLY EICO® —

the largest manufacturer of its kind in the world — gives you

LIFETIME SERVICE & CALIBRATION GUARANTEE*

...the Industry's greatest protection for your test equipment investment!



- Audibly signal traces all IF, RF, Video & Audio circuits from ANT to SPKR or CRT in all TV, FM, AM, etc. without switching.
- Germanium crystal diode probe responsive to over 200 mc.
- Integral test speaker.

145K SIG. TRACER KIT $19.95. WIRED $28.95.

* at less than our cost of handling (see the EICO Guarantee Card enclosed with each Kit and Instrument).

NEW!

SCOPE VOLTAGE CALIBRATOR KIT 495K KIT $12.95. WIRED $17.95.
- Sq. wave output at power-line freq. with full-scale readings of .1, 1, 10 or 100 V. peak-to-peak.
- Accuracy ± 5% of full-scale on each range.

- 1000 Ω/V; 31 ranges
- DC/AC volts: Zero to 1, 5, 10, 50, 100, 500, 5000.
- DC/AC Current: 0-1, 10 ma; 0.1, 1 A.
- Ohms: 0-500, 100 K, 1 meg.

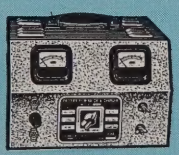
536K MULTIMETER KIT $12.90. WIRED $14.90.

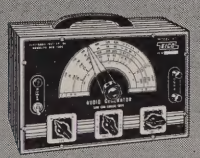
- Fundamentals 150 kc to 34 mc, harmonics to 102 mc.
- 5-step band switching.
- Colpitts audio oscillator generates 400 cps pure sine wave voltage.
- Permits pure RF, modulated RF, or pure AF.

320K SIG. GEN. KIT $19.95. WIRED $29.95.

NEW!

6V & 12V BATTERY ELIMINATOR KIT 1050K KIT $29.95. WIRED $38.95.
- DC output: 0-8 V or 0-16 V.
- Continuous current rating: 10 A at 6 V, 6 A at 12 V.
- Intermittent current rating: 20 A at 6 V, 12 A at 12 V.
- Separate Voltmeter & Ammeter.





- Complete sine wave coverage, 20-200,000 cps in 4 direct-reading ranges.
- Complete square wave coverage, 60-50,000 cps.
- Cathode follower output circuit.

377K SINE & SQUARE WAVE AUDIO GEN. KIT $31.95. WIRED $49.95.

- Resistance values from 0 to 99,999 ohms with 0.5% precision.
- All resistors have 0.5% accuracy.

1171K RES. DECADE BOX KIT $19.95. WIRED $24.95.

NEW!

DECADE CONDENSER BOX KIT 1180K KIT $14.95. WIRED $19.95.
- All capacitors precision silver mica, accuracy ± 1%.
- Range from 100 mmf — 0.111 mfd in steps of 100 mmf.
- Smooth-action positive detent ceramic switches.

Prices 5% higher on West Coast. Specifications and prices subject to change without notice.

- 20,000 Ω/V; 31 ranges.
- DC/AC/Output volts: 0-2.5, 10, 50, 250, 1000, 5000.
- DC Current: 0-100 ua; 10, 100, 500 ma; 10 A.
- Ohms: 0-2K, 200K, 20 meg.

565K MULTIMETER KIT $24.95 WIRED $29.95.

- Covers range of 75 kc to 150 mc.
- 7 calibrated scales: accuracy better than 1%.
- Bandspread vernier tuning.
- 4-step RF shielded output multiplier: constant output Z.

315K DELUXE SIG. GEN. KIT $39.95. WIRED $59.95.

Write NOW for FREE latest Catalog

EICO®

You build EICO Kits in one evening, but . . . they last a lifetime!
And you ***SAVE OVER 50%!*** *See the famous EICO line TODAY, in stock at your local jobber.*

ELECTRONIC INSTRUMENT CO., Inc., 84 Withers Street, Brooklyn 11, N. Y.